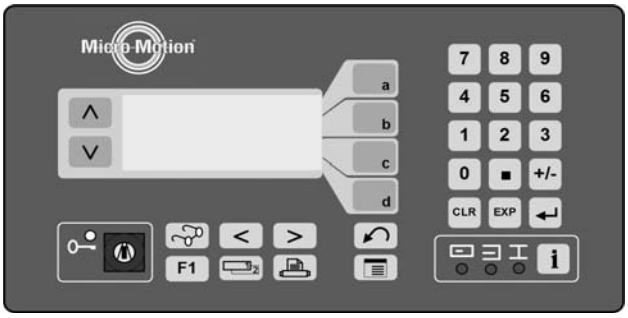
7951 Signal Converter

(With gas software 1020)

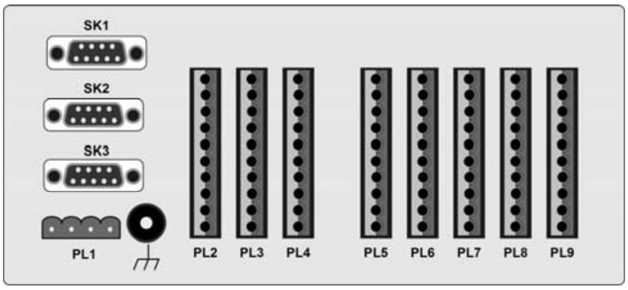
Micro Motion® 7951



Introduction:
The Micro Motion® 7951 Signal Converter can be used for dual-channel/stream gas applications.

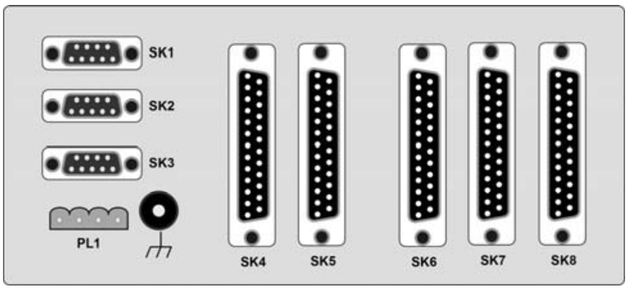
Software Version:
1020 – Gas Applications.

Klippon Connector Model



Models Covered:
`7951MAA0*****`

D-Type Connector Model



Models Covered:
`7951MAB0*****`

IMPORTANT NOTICE

Because we are continuously improving our products, some of the menus which appear on your instrument's display may not be exactly as illustrated and described in this manual. However, because the menus are simple and intuitive, this should not cause any major problems.

This manual is concurrent with embedded software version 511020, issue 2.10

Static precautions

Some parts of the instrument (such as circuit boards) may be damaged by static electricity. Therefore, when carrying out any work which involves the risk of static damage to the instrument, the instructions show the following notice:

⚠	<u>**CAUTION**</u>	**While carrying out this procedure, you must wear an earthed wrist strap *at all times* to protect the instrument against static shock.**

At such times **you must** wear an earthed wrist-strap to protect the instrument.

Safety information

NOTE: This information applies *only* to those instruments which are mains-powered.

Electricity is dangerous and you risk injury or death if you do not disconnect the power supplies before carrying out some of the procedures given in this manual. Whenever there is such a hazard, the instructions show a notice similar to the following:

⚠	<u>**WARNING**</u>	**Electricity is dangerous and can kill.** **Disconnect *all* power supplies before proceeding.**

You ***must*** heed any such warnings and make sure that, before you go any further:

- **All power leads are un-powered.**
- **All power leads are disconnected from the equipment which you are working on unless the instructions tell you otherwise.**
- **You obey any other common-sense precautions which may apply to your situation.**

If you obey these sensible precautions, you can work on the equipment in complete safety.

Battery-backed Memory notice

- It is essential that the **Lithium Cell** used for the battery backup is installed at all times (other than during replacement). The 7951 Micro Motion® Signal Converter will not power-up correctly if this battery is missing.

  If it is necessary to run the units without batteries for Intrinsic Safety reasons, then the battery should be replaced with a shorting disk inserted in the battery holder. Please consult the factory for further advice.
- Replace the battery when the "Low Battery" system alarm is indicated. The procedure is in Chapter 14.

CONTENTS

1. About this manual

1.1 What this manual tells you

This manual tells you how to install, configure, operate, and service the instrument. In addition, some information is given to help you identify and correct some of the more common faults which may occur. However, since repairs are done by changing suspected faulty assemblies, fault-finding to board component level is not covered.

This manual assumes that all devices or peripherals to be connected to the 795x have their own documentation which tells you how to install and configure them. For this reason it is assumed that anything which you want to link to the 795x is already installed and working correctly in accordance with the manufacturer's instructions.

Since the instrument can be used for a wide variety of purposes, it is driven by software specially for your application. This manual gives information about the software which applies to your machine only.

Throughout this manual the term '795x' is used to refer to all members of the 795x family (7950 and 7951).

1.2 Who should use this manual

This manual is for anyone who installs, uses, services or repairs the 795x.

1.3 Software version covered by this manual

The software version dealt with in this manual is given on the title page. Chapter 3 tells you about the software is installed in your instrument.

2. Getting started

2.1 What this chapter tells you

If you are new to the Micro Motion® 7951 Signal Converter, the worked examples in this chapter can help you to become familiar with the installation and configuration procedures. The examples are:

- Example 1: 7951 with a 7810/11/12 (See page 2.2)
- Example 2: 7951 with a 3096/3098 Gas Specific Gravity (See page 2.6)
- Example 3: 7951 with a mA-type temperature transmitter (See page 2.9)
- Example 4: 7951 with a mA-type pressure transmitter (See page 2.12)
- Example 5: 7951 with a PRT-type temperature transmitter (See page 2.14)

Work through whichever one is most like your installation.

2.2 What the examples show you

Each example shows you how to:

- wire up a simple system
- set the DIP switches inside the 7951
- find the menu from which you start configuration
- clear the memory of details of any existing configuration (**OPTIONAL**)
- select the appropriate wizard to configure the simple system
- work through the wizard and button in information
- view the results of your configuration

The examples do not give full instructions on how to fit and configure installations. They are intended purely to give you confidence to install and configure your own equipment. Chapter 5 tells you how to make permanent installations.

2.3 If you need help...

If you get into difficulties...

If you get into difficulties when using the wizards, you can abandon the configuration and start again as follows:

1. From the menu, keep selecting NO (usually by pressing the **c-button**) or, if that option is not available:
2. Press **ENTER** until you can start selecting NO.
3. Carry on with (1) and (2) until you return to the wizards menu where you started.
4. Start the worked example again. The configuration you abandoned is cleared from the instrument's memory when you begin again.

If you don't know where the buttons are...

Chapter 6 shows how to find all the buttons referred to in the worked examples.

2.4 Example 1: 7951 with a 7810/11/12 gas density meter

About this example

This **NON-HAZARDOUS (SAFE) AREA ONLY INSTALLATION**† example shows you how to connect either a 7810, 7811 or 7812 gas density meter to the 7951, and then uses the "Density 1" wizard to configure the system.

In this example, the "Density 1" wizard is used to configure a connection as follows:

- A single densitometer is connected to **Density Input 1**.

Work through the example by following the instructions below. If you are not sure where the buttons are, refer to Chapter 6.

Connect the meter	1. Wire the meter to the 7951, as in: **Figure 2.1** for a 7810 or a 7811 gas density meter ***OR*** **Figure 2.2** for a 7812 gas density meter. **Note:** Refer to meter documentation for other wiring arrangements. 2. Earth the 7951 to a suitable earth point. **EMC Notes:** To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the Flow Computer be connected to transducers using a suitable instrumentation cable containing individually shielded twisted pairs and an overall screen to cover all cores. The instrumentation cables should have **individual screen(s)**, foil or braid over each twisted pair and an **overall screen** to cover all cores. Where permissible, and depending on the earthing scheme employed at the installation, the overall screen should be connected to the earthed metal work at *both ends* (360° bonding where possible). This may have multiple protective earth connections to the pipe work or the building structure and not connected to the individual screen(s) or Instrumentation or Zener barrier grounds. The individual inner screen(s) should be connected at *one end only*, normally the controller (e.g. Flow Computer) end. These should be connected to the Instrumentation or Zener barrier ground. Use suitable cables that meet BS5308 multi-pair Instrumentation Types 1 or 2.

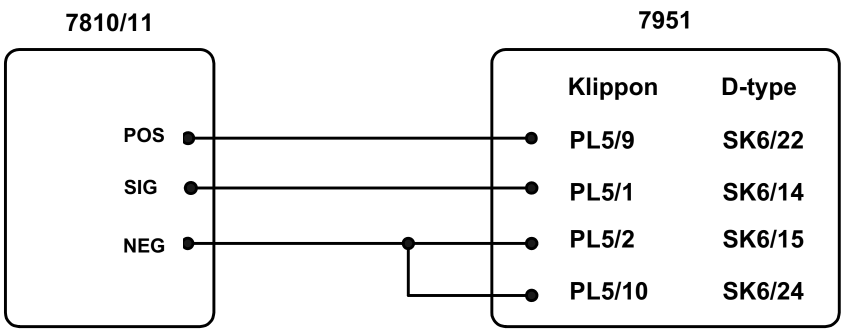


Figure 2.1: Safe area wiring for a 7810/11 (3-wire arrangement)

† Hazardous area considerations: Refer to meter documentation for details of Intrinsically Safe Barrier/Isolator requirements.

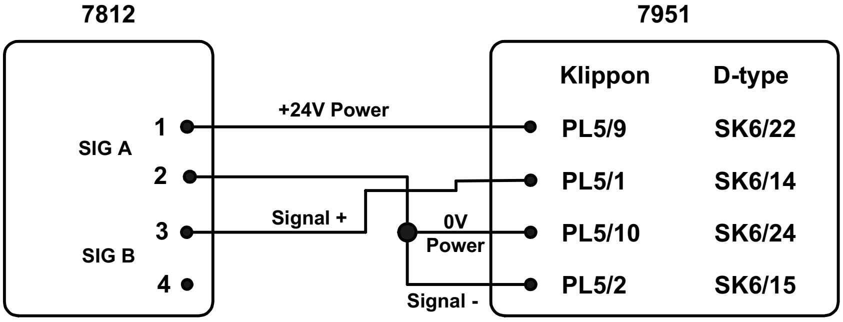
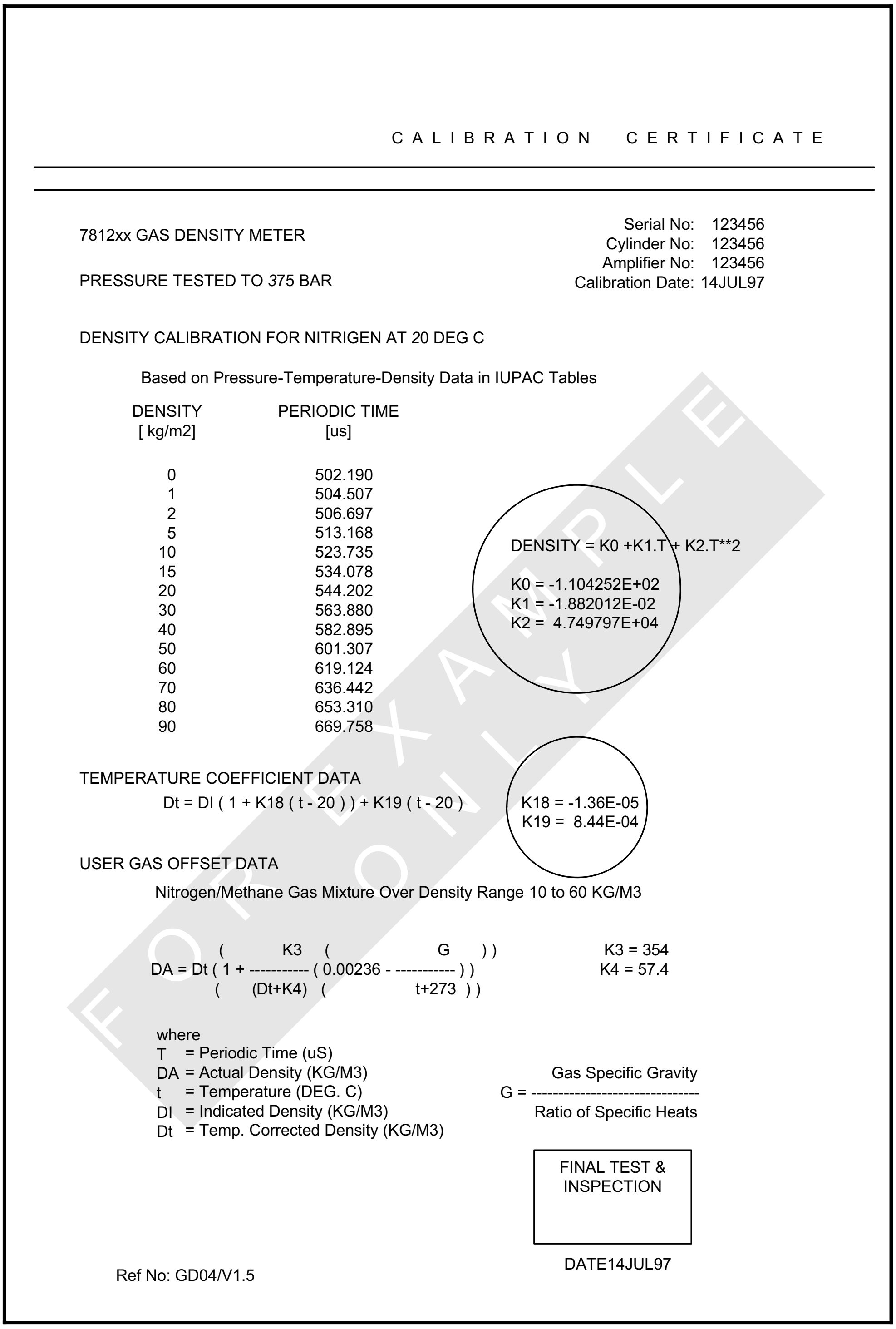


Figure 2.2: Safe area wiring for a 7812 (3-wire arrangement)

Turn on the power	3. Turn on the power to the system. The system goes through a Power On Self Test (POST) routine which takes less than 30 seconds. When it is finished, ignore any flashing alarm lights which may appear.
Go to the wizards menu	4. Press the **MENU** button to go to Page 1 of the Main Menu (if you aren't there already). 5. Press the **DOWN-ARROW** button *twice* (to go to page 3 of the menu). 6. Press the **b-button** to select "Configure". 7. Press the **a-button** *twice* to go to the wizards menu.
Clear existing configuration **(This is optional)**	8. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "*Initialise*" is shown. 9. Press the **b-button** to select "*Initialise*". 10. Press the **d-button** to confirm that you want to lose the current configuration. 11. Wait a few seconds until "*initialise*" on line 2 of the display changes back to "*Choose option*".
Select the wizard	12. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "Density 1" is shown. 13. Press the **b-button** to select "Density 1".
Start of wizard	14. Press the **d-button** to answer YES to "Edit Gas density A?"
Enter densitometer calibration factors	15. Press the **b-button**, and then input the factor K0 from the Calibration Certificate that was shipped with the meter. 16. Press the **b-button** then **ENTER** to confirm the K0 value. 17. Enter values for factors K1 and K2 in the same way as for K0. **Note**: Figure 2.4 on page 2.4 shows where to find the K0, K1 and K2 factors on a calibration certificate. Always use values from the calibration certificate that was shipped with the connected meter.
Enter temperature correction factors	18. Press **b-button** to start the correction selection process. 19. Use the **UP-ARROW** button to scroll through the options until "Temp" appears on line 2. 20. Press the **b-button** and then the **ENTER** button to confirm that temperature correction is to be applied. 21. Enter factors K18 and K19 in the same way as for K0, K1 and K2.
Skip over the next few questions	22. Press the **ENTER** button to skip past the "Density offset" prompt 23. Keep pressing the **c-button** (to answer NO to all questions) *until* the wizard is exited.
View how you have configured Line density	24. Press the **MENU** button. 25. Press the **a-button** *twice*. The display looks similar to that shown in **Figure 2.3**, although values and titles shown may vary.

Figure 2.3: Prime Line density display



CALIBRATION CERTIFICATE

7812xx GAS DENSITY METER

PRESSURE TESTED TO 375 BAR

Serial No: 123456
Cylinder No: 123456
Amplifier No: 123456
Calibration Date: 14JUL97

DENSITY CALIBRATION FOR NITRIGEN AT 20 DEG C

Based on Pressure-Temperature-Density Data in IUPAC Tables

DENSITY [kg/m2]	PERIODIC TIME [us]
0	502.190
1	504.507
2	506.697
5	513.168
10	523.735
15	534.078
20	544.202
30	563.880
40	582.895
50	601.307
60	619.124
70	636.442
80	653.310
90	669.758

DENSITY = K0 +K1.T + K2.T**2

K0 = -1.104252E+02
K1 = -1.882012E-02
K2 = 4.749797E+04

TEMPERATURE COEFFICIENT DATA

Dt = DI (1 + K18 (t - 20)) + K19 (t - 20)

K18 = -1.36E-05
K19 = 8.44E-04

USER GAS OFFSET DATA

Nitrogen/Methane Gas Mixture Over Density Range 10 to 60 KG/M3

$$DA = Dt \left(1 + \frac{K3}{Dt+K4} \left(0.00236 - \frac{G}{t+273} \right) \right)$$

K3 = 354
K4 = 57.4

where
T = Periodic Time (uS)
DA = Actual Density (KG/M3)
t = Temperature (DEG. C)
DI = Indicated Density (KG/M3)
Dt = Temp. Corrected Density (KG/M3)

$$G = \frac{\text{Gas Specific Gravity}}{\text{Ratio of Specific Heats}}$$

FINAL TEST & INSPECTION

DATE14JUL97

Ref No: GD04/V1.5

Figure 2.4: Circled areas on an example calibration certificate showing where to find values for K0, K1, K2, K18 and K19.

View the Multi-view display	26. Press the **MULTI-VIEW DISPLAY** button. The display looks similar to that in **Figure 2.5**, although values shown may vary. 27. Pressing the **DOWN-ARROW** button results in the message: "Invalid Multiview Page" This appears because it is possible to have more than one Multiview page and it is simply saying that no more pages exist. In this case, only four items are defined and they fit on one page. Pressing the **UP-ARROW** button makes the previous page to re-appear. Note that it may be necessary to press the **UP-ARROW** button several times before the first Multi-view page appears.

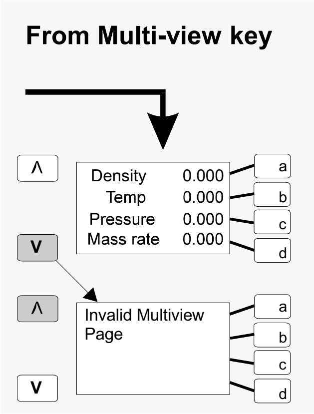


Figure 2.5: Multi-view display

End of Worked Example 1

2.5 Example 2: 7951 with a 3096/3098 Gas Specific Gravity Meter

About this example

This example shows you how to connect a 3096/3098 to the 7951 and then use the “SG 1” wizard to configure the system.

In this example, the “SG 1” wizard is used to configure a connection as follows:

- A single 3096/3098 is connected to **Density Input 3**.

Work through the example by following the instructions below. If you are not sure where the buttons are, refer to Chapter 6.

Connect the meter	1. Wire the meter to the 7951, as in : **Figure 2.6** for a NON-HAZARDOUS (SAFE) AREA ***OR*** **Figure 2.7** for a HAZARDOUS AREA 2. Earth the 7951 to a suitable earth point. **EMC Notes:** To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the Flow Computer be connected to transducers using a suitable instrumentation cable containing individually shielded twisted pairs and an overall screen to cover all cores. The instrumentation cables should have **individual screen(s)**, foil or braid over each twisted pair and an **overall screen** to cover all cores. Where permissible, and depending on the earthing scheme employed at the installation, the overall screen should be connected to the earthed metal work at *both ends* (360° bonding where possible). This may have multiple protective earth connections to the pipe work or the building structure and not connected to the individual screen(s) or Instrumentation or Zener barrier grounds. The individual inner screen(s) should be connected at *one end only*, normally the controller (e.g. Flow Computer) end. These should be connected to the Instrumentation or Zener barrier ground. Use suitable cables that meet BS5308 multi-pair Instrumentation Types 1 or 2.

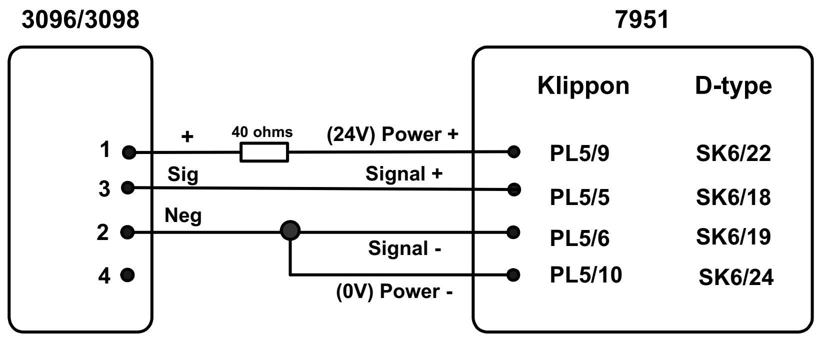


Figure 2.6: Non-hazardous (Safe) area wiring for a 3096/3098

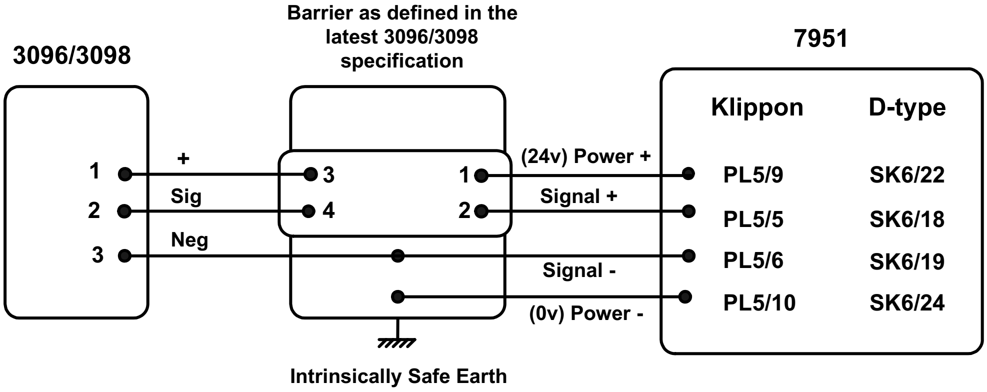


Figure 2.7: Hazardous area wiring for a 3096/3098

Turn on the power	3. Turn on the power to the system. The system goes through a Power On Self Test (POST) routine which takes less than 30 seconds. When it is finished, ignore any flashing alarm lights which may appear.
Go to the wizards menu	4. Press the **MENU** button to go to Page 1 of the Main Menu (if you aren't there already). 5. Press the **DOWN-ARROW** button twice (to go to page 3 of the menu). 6. Press the **b-button** to select "Configure". 7. Press the **a-button** *twice* to go to the wizards menu.
Clear existing configuration **(This is optional)**	8. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "*Initialise*" is shown. 9. Press the **b-button** to select "*Initialise*". 10. Press the **d-button** to confirm that you want to lose the current configuration. 11. Wait a few seconds until "*initialise*" on line 2 of the display changes back to "*Choose option*".
Select the wizard	12. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "SG 1" is shown. 13. Press the **b-button** to select "SG 1".
Start of wizard	14. Press the **d-button** to answer YES to the question "Edit Gravitometer A?".
Enter gravitometer calibration factors	15. Press the **b-button**, then input the factor K2 from the Calibration Certificate that was shipped with the meter. 16. Press the **b-button** then **ENTER** to confirm the K2 value. 17. Press the **b-button**, then input the factor K0 from the Calibration Certificate that was shipped with the meter. 18. Press the **b-button** then **ENTER** to confirm the K0 value.
Skip over other questions	19. Press the **c-button** several times (to answer NO to all questions) *until* the wizard is exited.
View how you have configured Specific gravity	20. Press the **MENU** button. 21. Press the **c-button** and then press the **a-button**. The display looks similar to that shown in **Figure 2.8** although values shown may vary.

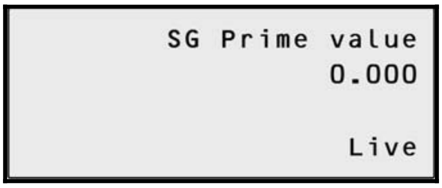


Figure 2.8: Prime Specific Gravity display

View the Multiview display	22. Press the **MULTI-VIEW DISPLAY** button. The display looks similar to that in **Figure 2.9**, although values and titles shown may vary.

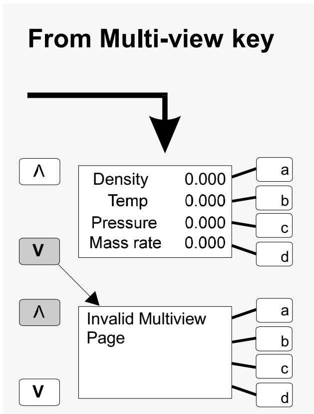


Figure 2.9: Multi-View display

End of Worked Example 2

2.6 Example 3: 7951 with a mA-type temperature transmitter

About this example

This example shows you how to connect a mA-type temperature transmitter to the 7951, and then use the "Temperature" wizard to configure the system.

In this example, the "Temperature" wizard is used to configure connections as follows:

- A single temperature transmitter is connected to **Analogue Input 3**.

Now work through the example by following the instructions below. If you are not sure where the buttons are, refer to the diagram at the start of this chapter.

Connect the meter	1. Wire the temperature transmitter to the 7951, as in **Figure 2.10** 2. Earth the 7951 to a suitable earth point. **EMC Notes:** To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the Flow Computer be connected to transducers using a suitable instrumentation cable containing individually shielded twisted pairs and an overall screen to cover all cores. The instrumentation cables should have **individual screen(s)**, foil or braid over each twisted pair and an **overall screen** to cover all cores. Where permissible, and depending on the earthing scheme employed at the installation, the overall screen should be connected to the earthed metal work at *both ends* (360° bonding where possible). This may have multiple protective earth connections to the pipe work or the building structure and not connected to the individual screen(s) or Instrumentation or Zener barrier grounds. The individual inner screen(s) should be connected at *one end only*, normally the controller (e.g. Flow Computer) end. These should be connected to the Instrumentation or Zener barrier ground. Use suitable cables that meet BS5308 multi-pair Instrumentation Types 1 or 2.
Set DIP switch	3. Ensure that the DIP-switch, inside the 7951, is set as shown below.

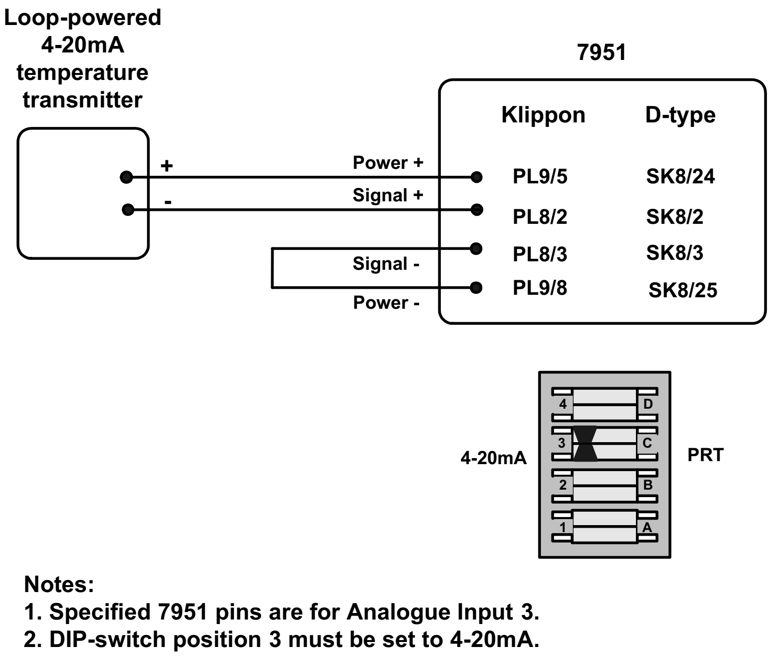


Figure 2.10: DIP-switch and safe area wiring for a mA-type temperature transmitter

Turn on the power	4. Turn on the power to the system. The system goes through a Power On Self Test (POST) routine which takes less than 30 seconds. When it is finished, ignore any flashing alarm lights which may appear.
Go to the wizards menu	5. Press the **MENU** button to go to Page 1 of the Main Menu (if you aren't there already). 6. Press the **DOWN-ARROW** button twice to go to Page 3 of the menu. 7. Press the **b-button** to select "Configure". 8. Press the **a-button** *twice* to go to the wizards menu.
Clear existing configuration **(This is optional)**	9. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "*Initialise*" is shown. 10. Press the **b-button** to select "*Initialise*". 11. Press the **d-button** to confirm that you want to lose the current configuration. 12. Wait a few seconds until "*initialise*" on line 2 of the display changes back to "*Choose option*".
Select the wizard	13. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "Temperature" is shown. 14. Press the **b-button** to select "Temperature".
Start of wizard	15. Press the **d-button** to answer YES to the question "Edit Line Temperature?".
Choose the Analogue Input	16. Press the **b-button** 17. Press the **UP-ARROW** button until "Analogue input 3" appears. 18. Press the **b-button** and then the **ENTER** button to confirm selection of "Analogue input 3".
Select the type of Analogue Input	19. Press the **ENTER** button to keep the default selection of a 4-20mA type input.
Set Analogue 0% and 100% range	20. Press the **b-button**. 21. Type in a suitable maximum temperature value and then press the **ENTER** button.
	22. Press the **ENTER** button to move on to the next prompt. 23. Press the **b-button**. 24. Type in a suitable minimum temperature value and then press the **ENTER** button. 25 Press the **ENTER** button to move on to the next prompt.
Make the Analogue Input "live"	26. Press the d-button. 27. Press the **UP-ARROW** button so that "Set" changed "Live". 28. Press the **ENTER** button once.
Skip over the next few questions	29. Press the **c-button** several times to answer NO to all questions *until* the wizard is exited.
View how you have configured Line temperature	30. Press the **MENU** button. 31. Press the **d-button** and then press the **a-button**. The display looks similar to that shown in **Figure 2.11** although values shown may vary.

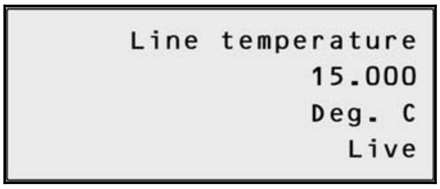


Figure 2.11: Line temperature data display

End of Worked Example 3

2.7 Example 4: 7951 with a mA-type pressure transmitter

About this example

This example shows you how to connect a mA-type pressure transmitter to the 7951, and then use the "Pressure" wizard to configure the system.

In this example, the "Pressure" wizard is used to configure a connection as follows:

- A single pressure transmitter is connected to **Analogue Input 3**.

Work through the example by following the instructions below. If you are not sure where the buttons are, refer to Chapter 6.

Connect the meter	1. Wire the transmitter to the 7951, as in **Figure 2.12**. 2. Earth the 7951 to a suitable earth point. **EMC Notes:** To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the Flow Computer be connected to transducers using a suitable instrumentation cable containing individually shielded twisted pairs and an overall screen to cover all cores. The instrumentation cables should have **individual screen(s)**, foil or braid over each twisted pair and an **overall screen** to cover all cores. Where permissible, and depending on the earthing scheme employed at the installation, the overall screen should be connected to the earthed metal work at *both ends* (360° bonding where possible). This may have multiple protective earth connections to the pipe work or the building structure and not connected to the individual screen(s) or Instrumentation or Zener barrier grounds. The individual inner screen(s) should be connected at *one end only*, normally the controller (e.g. Flow Computer) end. These should be connected to the Instrumentation or Zener barrier ground. Use suitable cables that meet BS5308 multi-pair Instrumentation Types 1 or 2.
Set DIP switch	3. Ensure that the DIP-switch, inside the 7951, is set as shown in Figure 2.12 .

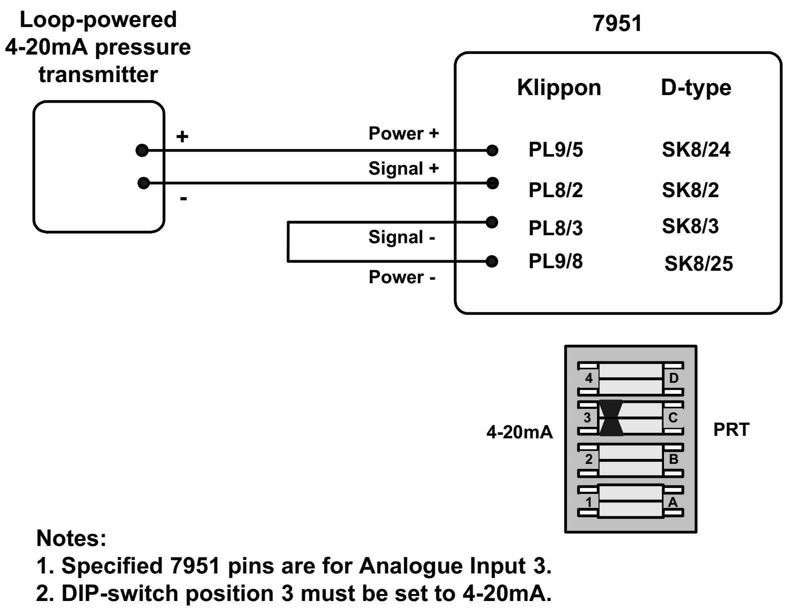


Figure 2.12: DIP-switch and safe area wiring for a mA-type pressure transmitter

Turn on the power	4. Turn on the power to the system. The system goes through a Power On Self Test (POST) routine which takes less than 30 seconds. When it is finished, ignore any flashing alarm lights which may appear.
Go to the wizards menu **Clear existing configuration** **(This is optional)**	5. Press the **MENU** button to go to Page 1 of the Main Menu (if you aren't there already). 6. Press the **DOWN-ARROW** button twice to go to Page 3 of the menu. 7. Press the **b-button** to select "Configure". 8. Press the **a-button** *twice* to go to the wizards menu. 9. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "*Initialise*" is shown. 10. Press the **b-button** to select "*Initialise*". 11. Press the **d-button** to confirm that you want to lose the current configuration. 12. Wait a few seconds until "*initialise*" on line 2 of the display changes back to "*Choose option*".
Select the wizard	13. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "Pressure" is shown. 14. Press the **b-button** to select "Pressure".
Start of wizard	15. Press the **d-button** to answer YES to the question "Edit Line Pressure?".
Choose the Analogue Input	16. Press the **b-button** 17. Press the **UP-ARROW** button until "mA input 3" appears. 18. Press the **b-button** and then the **ENTER** button to confirm selection of "mA input 3".
Set Analogue 0% and 100% range	19. Press the **b-button.** 20**.** Type in a suitable maximum pressure value and then press the **ENTER** button. 21. Press the **ENTER** button to move on to the next prompt 22. Press the **b-button** 23. Type in a suitable minimum pressure value and then press the **ENTER** button. 24 Press the **ENTER** button to move on to the next prompt
Select the type of Analog Input	25. Press the **ENTER** button to keep the default selection of a 4-20mA type input.
Make the Analogue Input "live"	26. Press the d-button 27. Press the **UP-ARROW** button so that "Set" changed "Live" 28. Press the **ENTER** button twice
Skip over other questions	29. Press the **c-button** several times to answer NO to all questions *until* the wizard is exited
View how you have configured Line pressure	30. Press the **MENU** button. 31. Press the **DOWN-ARROW** button. 32. Press the **a-button** *twice*. The display looks similar to that shown in Figure 2.13 although values shown may vary.

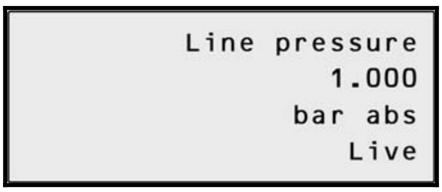


Figure 2.13: Line pressure data display

End of Worked Example 4

2.8 Example 5: 7951 with a PRT-type temperature transmitter

About this example

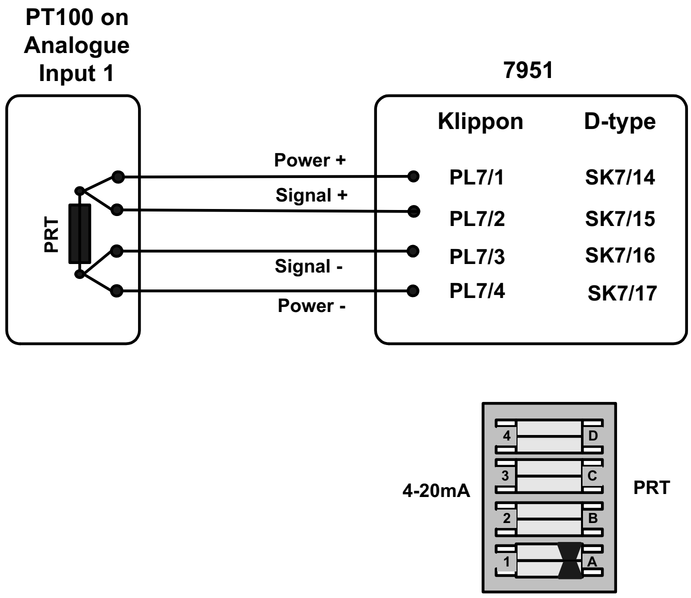
This example shows you how to connect a PT100 transmitter to the 7951, and then use the "Temperature" wizard to configure the system.

In this example, the "Temperature" wizard is used to configure a connection as follows:

- A single PT100 transmitter is connected to **Analogue Input 1**.

Work through the example by following the instructions below. If you are not sure where the buttons are, refer to Chapter 6.

Connect the meter	1. Wire the transmitter to the 7951, as in **Figure 2.14**. 2. Earth the 7951 to a suitable earth point. **EMC Notes:** To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the Flow Computer be connected to transducers using a suitable instrumentation cable containing individually shielded twisted pairs and an overall screen to cover all cores. The instrumentation cables should have **individual screen(s)**, foil or braid over each twisted pair and an **overall screen** to cover all cores. Where permissible, and depending on the earthing scheme employed at the installation, the overall screen should be connected to the earthed metal work at *both ends* (360° bonding where possible). This may have multiple protective earth connections to the pipe work or the building structure and not connected to the individual screen(s) or Instrumentation or Zener barrier grounds. The individual inner screen(s) should be connected at *one end only*, normally the controller (e.g. Flow Computer) end. These should be connected to the Instrumentation or Zener barrier ground. Use suitable cables that meet BS5308 multi-pair Instrumentation Types 1 or 2.
Set DIP switch	3. Set DIP-switch position 1 to "PRT" (for Analogue input 1).



Notes:
1. Specified 7951 pins are for Analogue Input 1.
2. DIP-switch position 1 must be set to PRT.

Figure 2.14: DIP switch and safe area wiring for a PRT-type temperature transmitter

Turn on the power	4. Turn on the power to the system. The system goes through a Power On Self Test (POST) routine which takes less than 30 seconds. When it is finished, ignore any flashing alarm lights which may appear.
Go to the wizards menu	5. Press the **MENU** button to go to Page 1 of the Main Menu (if you aren't there already). 6. Press the **DOWN-ARROW** button twice to go to Page 3 of the menu. 7. Press the **b-button** to select "Configure". 8. Press the **a-button** *twice* to go to the wizards menu.
Clear existing configuration **(This is optional)**	9. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "*Initialise*" is shown. 10. Press the **b-button** to select "*Initialise*". 11. Press the **d-button** to confirm that you want to lose the current configuration. 12. Wait a few seconds until "*initialise*" on line 2 of the display changes back to "*Choose option*".
Select the wizard	13. Press the **b-button** then the **UP-ARROW** or **DOWN-ARROW** button to scroll through the option list until "Temperature" is shown. 14. Press the **b-button** to select "Temperature".
Start of wizard	15. Press the **d-button** to answer YES to the question "Edit Line Temperature?".
Choose the Analogue Input	16. Press the **b-button**. 17. Press the **UP-ARROW** button until "Analogue input 1" appears. 18. Press the **b-button** and then the **ENTER** button to confirm selection of "Analogue input 1".
Choose the type of Analogue Input	19. Press the **b-button**. 20. Press the **UP-ARROW** button until "PT100 input" appears on line 2. 21. Press the **ENTER** button *twice* to select this PRT-type input.
Make the Analogue Input Channel "live"	22. Press the **d-button**. 23. Press the **UP-ARROW** button so that "Set" has changed to "Live". 24. Press the **ENTER** button *twice*.
Skip over other questions	25. Press the **c-button** several times (to answer NO to all further questions) *until* the wizard is exited.
View how you have configured Line temperature	26. Press the **MENU** button. 27. Press the **d-button** and then press the **a-button**. The display looks similar to that shown in **Figure 2.15** although values shown may vary.

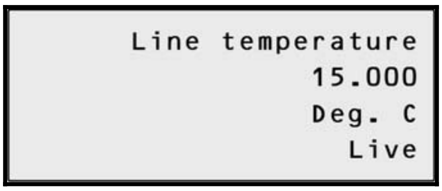


Figure 2.15: Line temperature display

End of Worked Example 5

3. About the *Micro Motion® 7951*

3.1 Background

The *Micro Motion® 7951* is designed to meet the demand for a reliable, versatile, user-friendly and cost-effective instrument for liquid and gas metering. It has a Motorola 68332 32-bit microprocessor and surface-mounted circuit board components so that it is powerful, reliable and compact.

Features of the *7951* include:

- Simple access to information.
- Comprehensive interrogation facilities.
- Alarm and alarm history facilities.
- A menu-driven, user-friendly interface.
- NEMA12, IP52 panel mounted case.
- Dc powered.
- Three serial ports (using RS232 or RS485) for Modbus communications and printing.

These facilities are described in more detail in the rest of this chapter.

3.2 What the *7951* Dual Channel Gas Signal Converter does

The *7951* Gas Signal Converter is primarily used to convert signals from one format to another. There is a need for this conversion when a system is unable to accept a raw signal from a transducer or, perhaps, some intermediate signal processing is required.

A common conversion is where a frequency input from a 7812 gas density transducer can be accepted by a 795x and then transmitted (by the same 795x) through an analogue output as a 4-20mA signal.

In this application, the *7951* can calculate:

- Line density √ (from Transducer, PTZ method or mA-type input)
- Specific gravity √ (from Transducer, mA-type input or Base density)
- Base density √ (from Specific gravity method, PTZ method or mA-type input)
- Energy (Cv/m) (from AGA-5 method or mA-type input)

Note: Dual-channel measurements are available for Items marked with a √

It can also obtain:

- Line temperature.
- Densitometer temperature.
- Density pressure.
- Atmospheric pressure.
- Percentage of CO_2 (from a mA-type input)
- Percentage of N_2 (from a mA-type input)
- Compressibility (from S-GERG, NX19, NX19mod or NX19 3h)
- Special equations 1 and 2.

3.3 Physical description of the *7951*

The main body of the *7951* is a one-piece aluminium extrusion which provides the best possible EMC protection. The **keyboard** and **display** is attached to the front of the instrument and all electrical and communications connectors are mounted on the **Rear Panel**. The *7951* is available with two types of rear Panel - one with Klippon connectors, the other with D-type connectors.

The case contains four circuit boards. The **Processor Board** and the **Power Supply Board** are mounted horizontally. These are connected by plugs and sockets to the **Mother Board** which is mounted vertically at the back of the case. The **Connector Board** is parallel to the Mother Board to which it is joined.

The Keyboard and Display are wired to the Processor Board. The Connector Board holds the connectors to which external devices are linked.

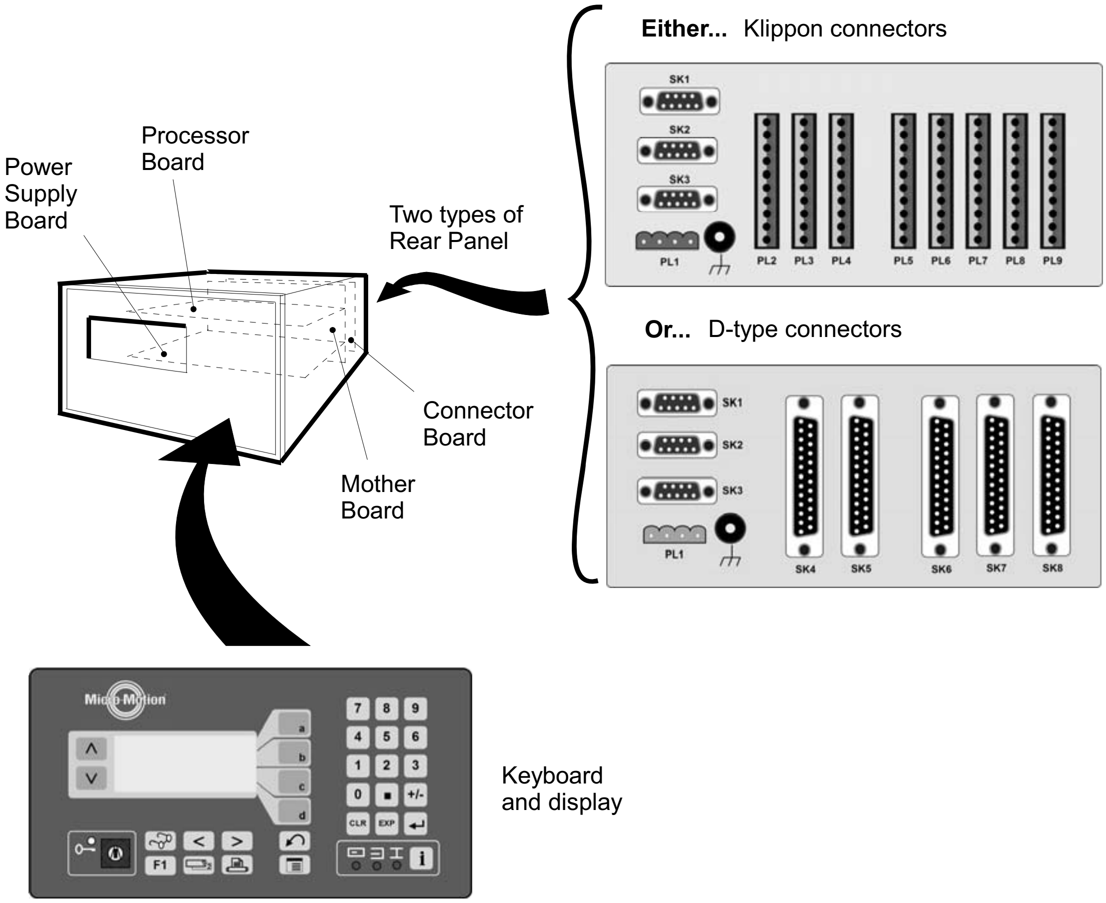


Figure 3.1: The 7951 and its major assemblies

3.4 Communications

The *7951* can operate as a MODBUS slave. It can:

- Download a configuration from a PC, DCS, etc.
- Upload a configuration.
- Monitor random locations in the *7951*.
- Interrogate the alarm and data logger buffers.
- Manipulate the alarm and data logger buffers.
- Set random locations with new data.
- Instigate printed reports.

3.5 Typical installations

The diagram below illustrates a typical installation utilising the *7951*.

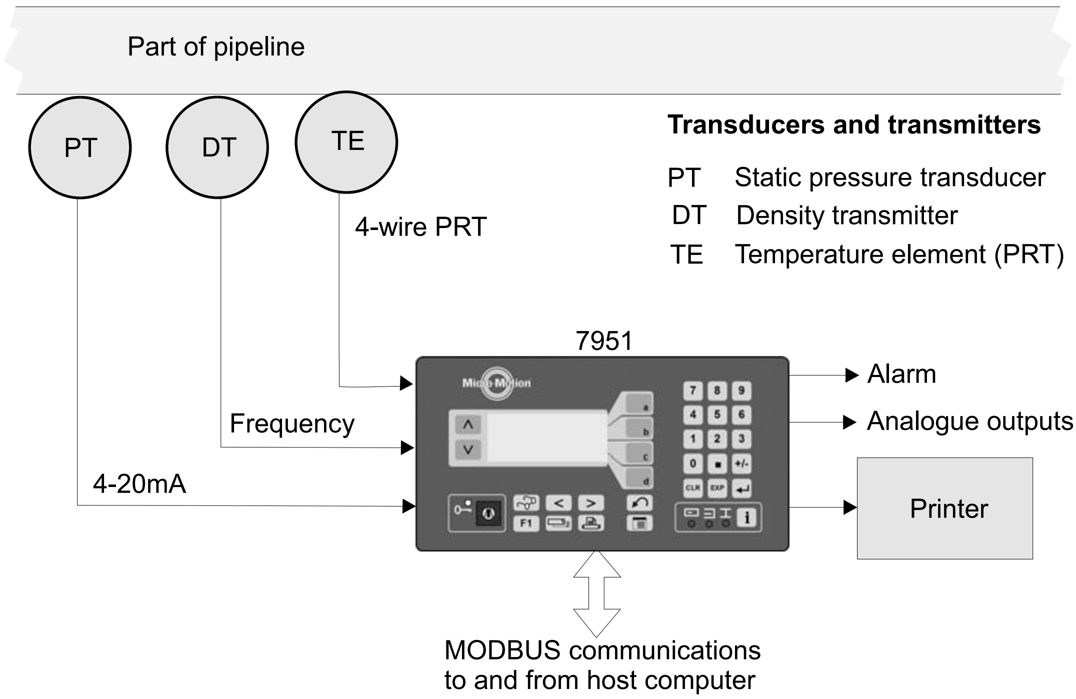


Figure 3.2: Typical installation for A Gas Signal Converter system

3.6 Checking your software version

The *7951* is driven by pre-loaded software which differs according to the application for which the instrument is to be used. To check hardware configuration, see Ordering Information in Appendix C.

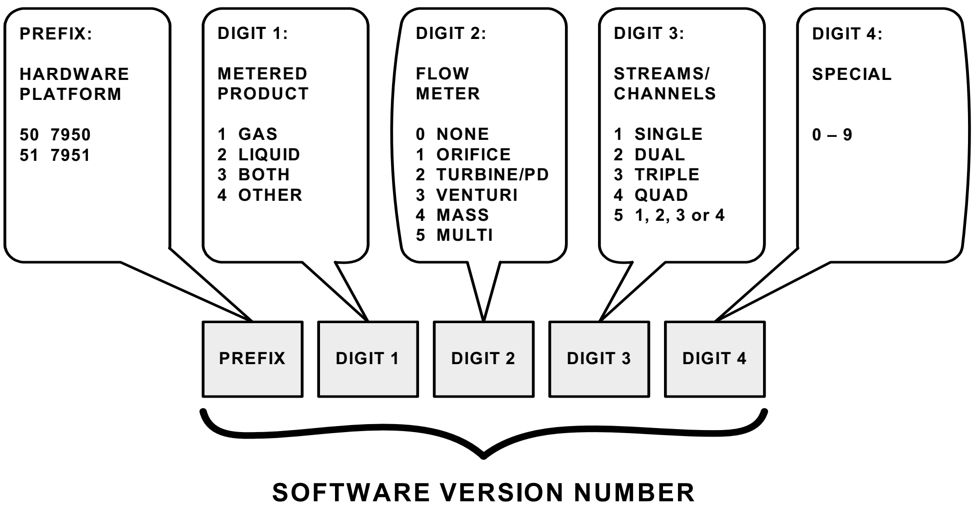


Figure 3.3: Software version number

For example, for a *7951 Dual-Channel Gas Signal Converter*, the software version number is **511020**. You can find the software version number in two ways:

1. It is printed on a label at the rear panel of the *7951*.

2. It is written into the menu structure – see Chapter 12.

4. What you can connect to a *7951*

The information in this chapter has been moved to Appendix C.

5. Installing the system

5.1 What this chapter tells you

This chapter gives full instructions for installing the *7951*.

It does not go into detail about how to install any peripheral devices (such as transducers, computers or printers) which are connected to the *7951*. For this information you must refer to the documentation supplied with these items.

5.2 Hazardous and non-hazardous environments

> ⚠ **Caution:**
> Always refer to documentation supplied by the manufacturer for details of installing their equipment in a hazardous area. **The *7951* is neither intrinsically safe nor explosion-proof. and can therefore only be used in a designated non-hazardous (safe) area.**

If all or part of an installation is in an area where there is the risk of fire or explosion (which is almost always the case when gases are involved), then **safety barriers** or **galvanic isolators** usually have to be wired into the circuit. However, some instruments are explosion-proof and barriers are not, therefore, needed.

5.3 Installation procedure

Briefly, the procedure is:

Step 1: Draw up a wiring schedule.

Step 2: Unpack the *7951*.

Step 3: Set the DIP switches.

Step 4: Fit the *7951*.

Step 5: Make all external connections.

Step 6: Earth the installation.

Step 7: Connect power supply.

The steps in the procedure are explained in the following sections.

5.4 Step 1: Drawing up a wiring schedule

Before you make any connections, you must draw up a wiring schedule to help you identify wiring colours and make sure that you do not connect more items of any given type than are allowed. (If you are in doubt, check the specification in Appendix C.)

A blank copy of a wiring schedule is given in Appendix B.

5.5 Step 2: Unpacking the instrument

Remove the instrument from its packing and examine it to see if any items are loose or if it has been damaged in transit. Check that all items on the shipping list are present. If any items are missing or if the equipment is damaged, contact your supplier immediately for further advice.

Note: If you have ordered an option card, this is already installed in the *7951*.

Table 5.1: What should be supplied with the *7951* (Klippon)

Item	Quantity
Mounting Clamp Assembly	1
Captive screws	2
Mounting strap	1
Location moulding	1
Socket identification label	1
9-way D-type plugs	3
9-way connector hoods	3
4-way socket	1
10-way sockets	8
2 Amp glass fuse (this is a spare)	1

Table 4.2: What should be supplied with the *7951* (D-type)

Item	Quantity
Mounting Clamp Assembly	1
Captive screws	2
Mounting strap	1
Location moulding	1
9-way D-type plugs	3
9-way D-type connector hoods	3
25-way D-type plugs	5
25-way D-type connector hoods	5
4-way socket	1
2 Amp ceramic fuse (this is a spare)	1

5.6 Step 3: Setting DIP-switches

Some types of connection may require **DIP-switches** to be set.

5.6.1 Analogue Input DP-switches

The *7951* has two blocks of DIP-switches on the Processor Board, as shown in Figure 5.1:

- **SW1 switches** – select whether each input is 4-20 mA or PRT.
- **SW2 switches** – not used in the current version of *7951*.

The setting of each switch in the SW2 block **must be the same** as the corresponding pair of switches in the SW1 block. The *7951* may not work correctly otherwise.

The *7951* is supplied with the DIP-switches in these default settings:

- Input 1 PRT
- Inputs 2-4: 4-20mA

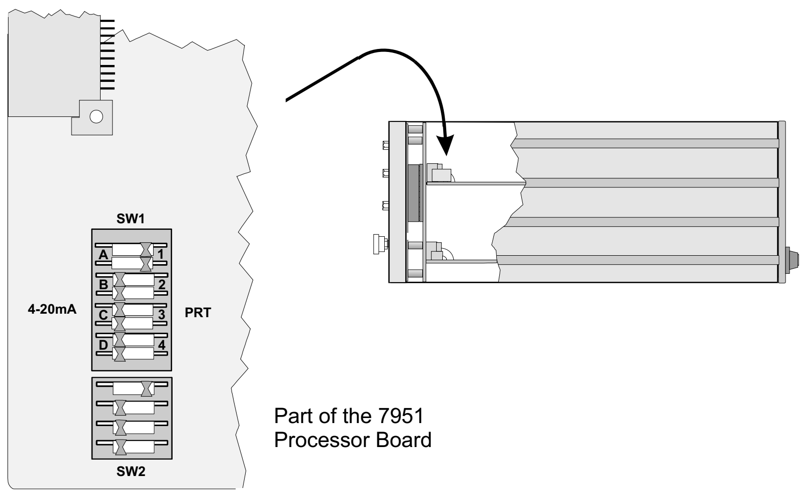


Figure 5.1: DIP-switches on the Processor Board

If you want to change the *Analog Input* switch settings, you must also configure the inputs. This is explained in chapter 11. After the configuration has been completed, the *7951* should be switched into the 'secure' mode to prevent unauthorised or accidental tampering with the instrument's configuration.

> **Note:**
> - The *7951* is always shipped from the factory with the security lock on the front panel set to the 'non-secure' mode.

5.6.2 Turbine Voltage Selection switches

The *Turbine Voltage Selection* switch is a DIP switch on the PSU Board, which is accessible through removal of parts (see Chapter 14). Choose between **8 volts dc** or **16 volts dc** for all flow meters powered by the *7951*. The *7951* is shipped with the switch set for 8 volts dc.

For flow meter connection details, see chapter 2.

5.7 Step 4: Fitting the *7951*

> **Caution:**
> You must not fit the *7951* where it may be subjected to extreme conditions or be liable to damage.
> For further information about the environmental conditions within which it can operate, see Appendix C.

1. Firstly, referring to Figure 5.2, cut out an aperture in the front panel for each instrument which is to be mounted on it.

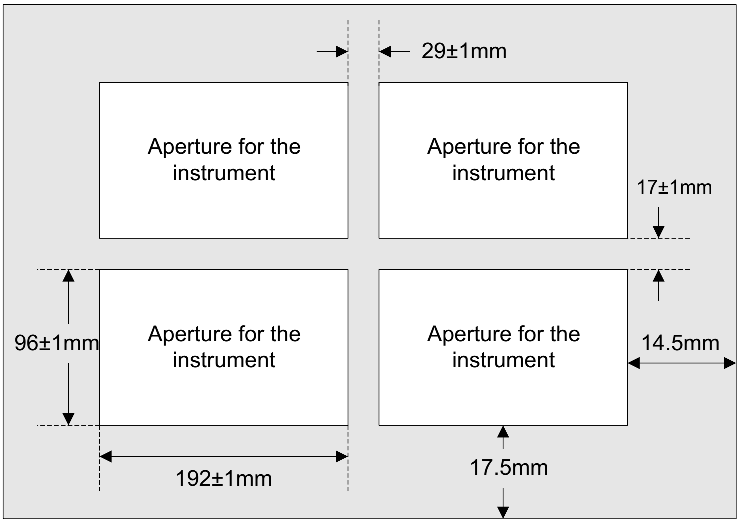


Figure 5.2: Minimum dimensions for a panel with apertures to fit four 7951's

2. Each instrument is mounted in a clamp which is fixed to the rear of the front panel, as shown in the two diagrams that follow.

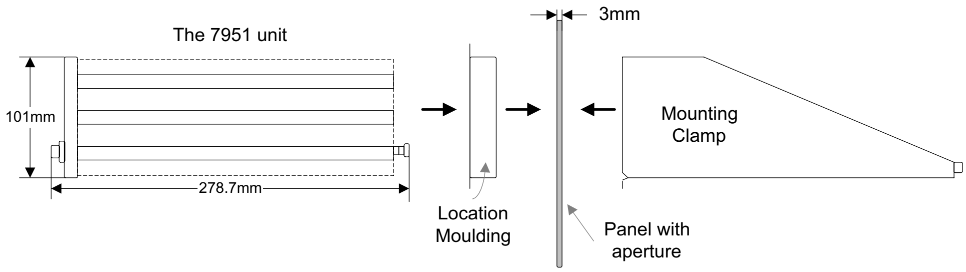
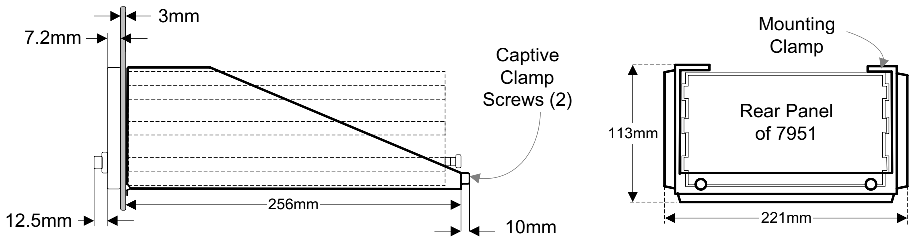


Figure 5.3: Before assembly



Note: Sufficient clearance is required for plugs and cables at the rear of the 7951

Figure 5.4: After assembly

You can mount the clamp so that it is fixed permanently or can be removed later, if required. If you want the clamp to be fixed permanently, carry out Steps 3 - 8. If you want to be able to remove the clamp, carry out Steps 9 - 12.

If the clamp is to be fixed permanently:

1. Make sure that the face of the front panel is in good condition and has no loose or flaking paint. Use a suitable de-greasing agent to clean the face of the panel.
2. Insert the location moulding through the aperture in the front panel.
3. Peel the protective strip off the adhesive tape on the face of the mounting clamp. Then, working from the back of the front panel, carefully position the clamp over the location moulding. The clamp and panel bond on contact.
4. Press firmly on the area where the clamp is bonded to the front panel to ensure that they are bonded firmly. Remove the Location Moulding and discard it.
5. Slide the instrument through the front panel. Tighten the two captive screws to secure it into the clamp.
6. Finally, attach all connectors to the back panel.

Note that, if you install more than one instrument, it helps to support them if you use a Mounting Strap to link each clamp to the next one, as shown in Figure 4.5:

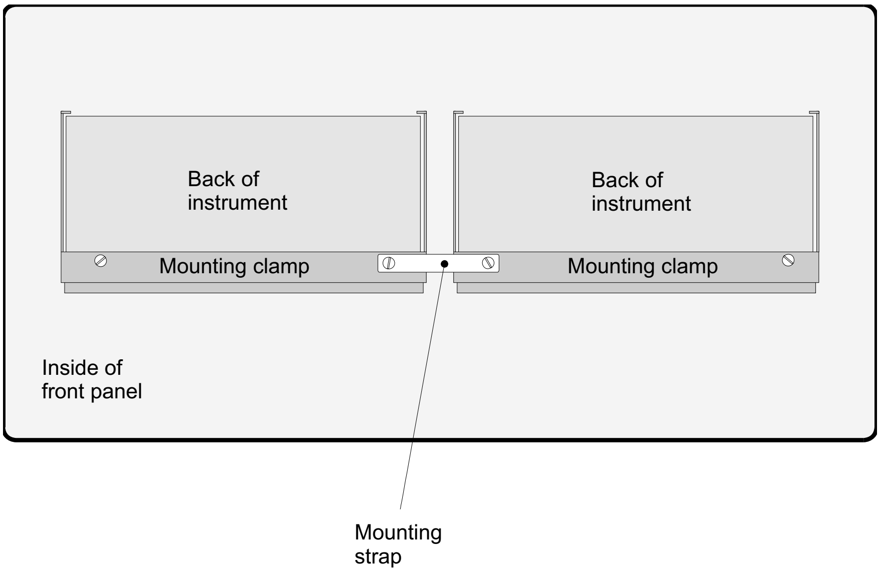


Figure 4.5: Mounting arrangements for more than one instrument

If the clamp is to be removable:

7. Insert the location moulding through the aperture in the front panel.
8. Working from the back of the front panel, carefully position the clamp over the location moulding. Remove the Location Moulding and discard it.
9. Slide the instrument through the front panel. Tighten the two captive screws to secure it into the clamp.

Note that, if you install more than one instrument, it helps to support them if you use a Mounting Strap to link each clamp to the next one, as shown in the diagram.

5.8 Step 5: Making the external connections

1. Refer to the documentation supplied with the external equipment to see if you have to carry out any special procedures when connecting them to the *7951*. Take special notice of any information about safety requirements in hazardous areas, and complying with EMC regulations.
2. For each **D-type connector**, pass the connector hood over the cable and wire up the connector. Secure the hood and connector body together then connect the earth wire to the hood. Stick an identifying label on to the connector hood.
3. For each **Klippon connector**, wire up the connector then stick an identifying label on it.
4. Check the wiring thoroughly against the schedule and wiring diagram.
5. Attach all connectors to the Rear Panel.

Refer to Chapter 2 and Appendix C for examples of field transmitter connections and a full list of the *7951's* pin identities.

5.9 Step 6: Earthing the instrument

Caution:
Incorrect earthing can cause many problems, so you must earth the chassis and the electronics correctly. The way in which you do this depends almost entirely on the type of installation you have and the conditions under which it operates. Therefore, because these instructions cannot cover every possible situation, the manufacturers recommend that earthing procedures should only be carried out by personnel who are skilled in such work.

The chassis of the *7951* must be earthed in all cases; both for safety reasons and to ensure that the installation complies with EMC regulations. Do this by connecting an earth lead from the stud on the rear panel (Figure 4.6) to a local safety earth such as a cabinet earth or some other suitable metal structure. If there is more than one *7951*, see Figure 4.7 for correct and incorrect methods.

In addition to earthing the chassis, you may have to make extra earth connections in some cases, depending on the installation requirements. **Details of internal earthing arrangements are in Appendix C**.

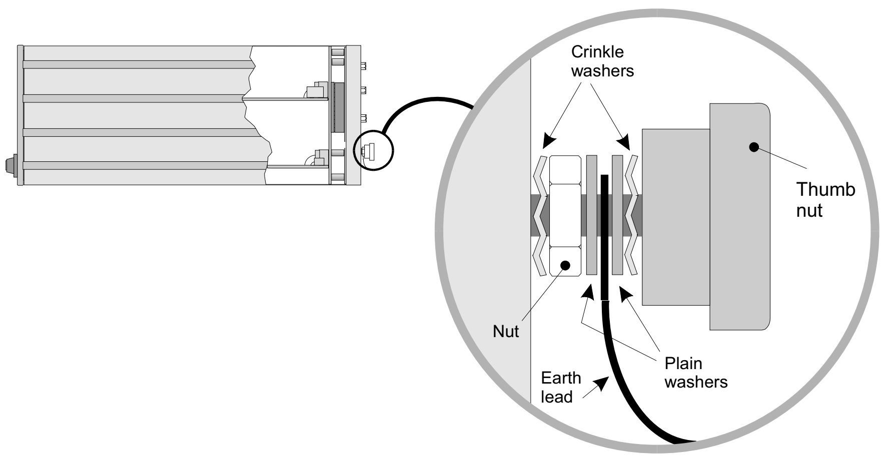
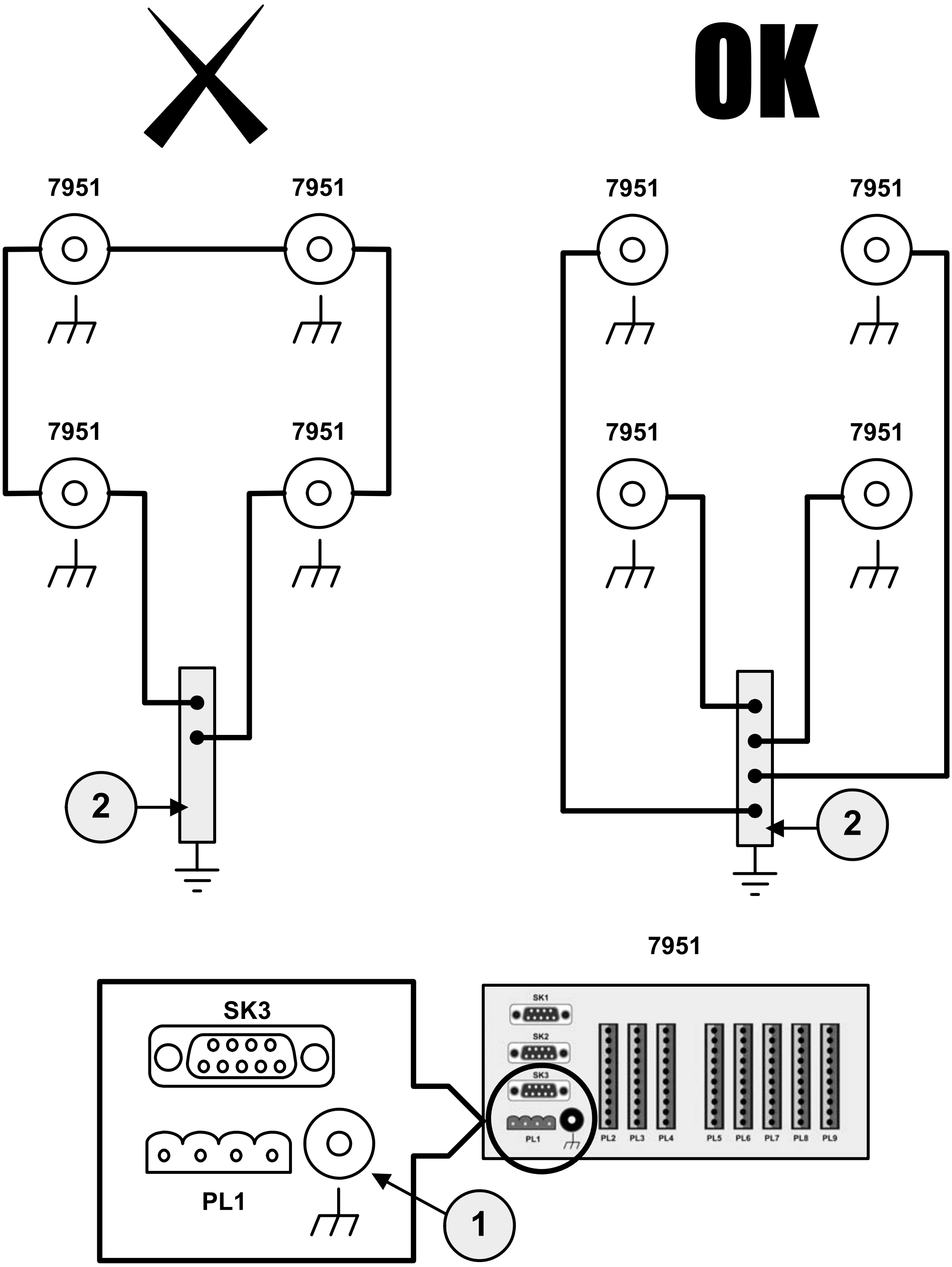


Figure 4.6: The *7951's* Earth Stud



(**1**) Earth stud on *7951* rear panel (D-type and Klippon).

(**2**) Cabinet earth or other suitable metal structure.

Figure 4.7: Multiple *7951* chassis earthing (through studs and earth leads)

5.10 Step 7: Connecting the power supply

Plug the dc power connector into plug **PL1** and switch on the power. The instrument goes through the following Power-On-Self-Test (POST) routine:

- The display shows a sequence of characters or patterns to prove that all elements of the display are working. There is a pause of five seconds between each change of pattern.
- The program ROM is checked against a checksum. The display shows how the test is proceeding.
- Critical data are checked. The display shows the result of this check.
- The coefficients are checked. The display shows the result of this check.
- The battery-backed RAM is checked. The display indicates progress.
- Any saved programs are checked. The display shows the number of programs and their status. Note that, for a new machine, there are no stored programs.
- If a battery is fitted, its condition is checked and reported.

Note that, when the power is switched on, the alarms may light up. You can ignore these for the moment, as alarms are explained later in this manual. You can now proceed to configure your *7951* (see Chapters 8-11).

If the POST fails to complete, switch off the power supply and check all connections and the DIP-switch settings. Then re-connect the power supply. If the POST still fails to complete, switch off again and contact your supplier.

6. The keyboard, display and indicators

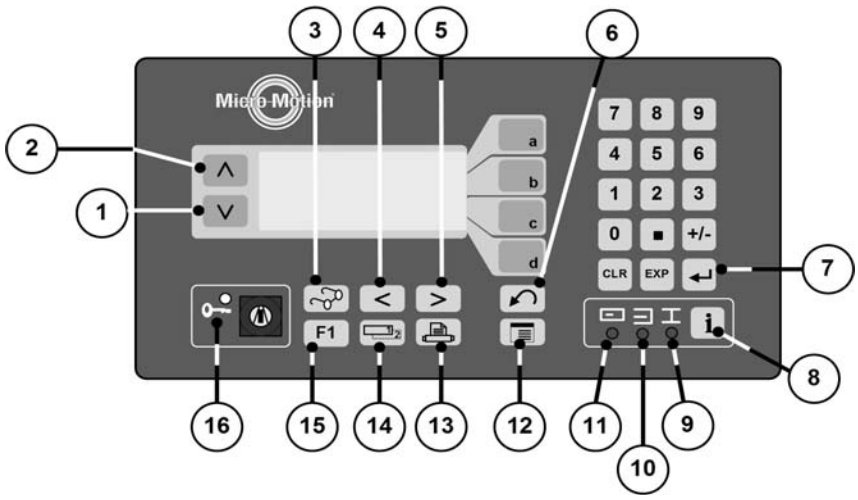
6.1 What this chapter tells you

This chapter tells you:

- How the front panel is laid out.
- What the buttons and indicators do.
- What characters you can display.

6.2 The layout of the front panel

Figure 6.1 shows the layout of the keyboard. The diagrams at the end of this chapter give a visual summary of what each of the buttons do.



1.	**DOWN-ARROW**	**7.**	**ENTER**	**13.**	**PRINT MENU**
2.	**UP-ARROW**	**8.**	**INFORMATION MENU**	**14.**	**STREAM/RUN SELECT**
3.	**MULTI-VIEW DISPLAY**	**9.**	**LIMIT ALARM LED**	**15.**	**F1 (software specific function)**
4.	**LEFT-ARROW**	**10.**	**INPUT ALARM LED**	**16.**	**SECURITY LED AND LOCK**
5.	**RIGHT-ARROW**	**11.**	**SYSTEM ALARM LED**		
6.	**BACK**	**12.**	**MAIN MENU**		

Figure 6.1: The layout of the front panel

6.3 What the display shows

The display can show the following information:

- Numerical data in floating point, exponent or integer formats.
- Text descriptors.
- Units of measurement (if applicable).
- Status of parameters i.e. set, live, failed or fallback (if applicable).
- Alarm and event information.
- Current time and date.
- Identification number (location ID) of parameter.
- Stream (metering-run) identification number (if applicable).

6.4 How the buttons work

The buttons let you:

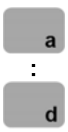
- Move around the menus.
- View data stored in the 795x – VIEW mode.
- Edit the data – EDIT mode.

Some buttons do different things according to where you are in the menu system. For example:

	**ENTER** button	This button does nothing until you get into EDIT mode. After you have edited the data of a parameter, pressing **ENTER** accepts the changes and puts the 795x back into VIEW mode.
	**c** button	When you move through the menu structure this selects any menu choice shown against the button. However, when in VIEW mode, pressing **c** lists the display units.
	**INFORMATION MENU** button	This button does nothing if you are in EDIT mode. At other times, it takes you to a special menu that provides information on alarms, events, flow status and 795x operating mode.
	**PRINT MENU** button	This button does nothing if you are in EDIT mode. At other times, it takes you to a special menu dealing with data archiving and printing of reports.

6.5 Using the buttons to move around the menus

A general tour of the menu system is provided in chapter 6. The buttons, which you can use to move around the menu system, are:

	**UP-ARROW**	Moves the display up to the previous page of the menu. If there is no previous page, this button does nothing.
	**DOWN-ARROW**	Moves the display down to the next page of the menu. If there is no next page, this button does nothing.
	**a - d** buttons	Each of these buttons selects the menu choice next to it. If there is no menu choice next to a button, that button does nothing.
	**BACK**	Returns you to the previous step.

	MAIN MENU	Moves you straight to page 1 of the top-level menu.
	INFORMATION MENU	Takes you to a special menu providing information on alarms, events, flow status and 795x operating mode.
	PRINT MENU	Takes you to a special menu dealing with data archiving and printing of reports.
	MULTI-VIEW	You can define one or more display pages, each showing up to four items of data, lines of descriptive text, or both. Pressing **MULTI-VIEW** shows the first display page you have defined. Use the up/down arrow buttons to page up and page down.
F1	**F1**	The use of this button is dependent on the functionality of the application software. If this button is in use, it will be mentioned in later chapters.

Note: All other buttons have no effect when moving around the menus.

6.6 Using the buttons to view stored data

When a software parameter screen is viewed, after selection from the menu, the display is in **VIEW** mode.

Figure 6.2 shows a typical display when you view a software parameter screen. In **VIEW** mode, all information is in a *right justified* format.

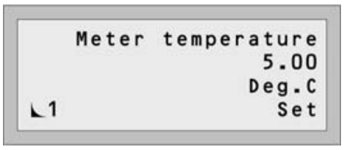


Figure 6.2: A typical software parameter screen (in VIEW mode)

What the display shows

Line 1: Shows the parameter description. (Some words are abbreviated.)

Line 2: Shows the present value (or text for indirection type).

Line 3: Shows the measurement units (if any). This line is blank if there are no units.

Line 4: The right-hand side shows LIVE, SET, FB (FALLBACK) or FAIL to indicate the state of the present value shown in Line 2, where appropriate. These indications mean:

LIVE – The data shown is live data received from the transducer/transmitter connected to the *795x* **or** calculated by the *7858* rather than a set value.

SET – There is a fixed value for the data; this value does not change unless you enter a new fixed value or make it live.

FB – A fallback or default value has been used to obtain the value for the data.

FAIL – The live input has failed, most likely due to no transducer/transmitter being connected **or** a calculation failed to complete due to incorrect configuration.

An alarm will be raised causing the Input Alarm LED to flash on the front panel. For troubleshooting this alarm, see chapter 8.

Optionally, **Line 4** may also show the parameter's unique identification number (location ID), which is required when setting up certain features e.g. Multi-view. You can toggle this information on/off by the '**a**' button.

In **VIEW** mode, the buttons that you can use are:

'a' button	On/off toggle for displaying the parameter's unique identification number (location ID). This is displayed to the left of the status indication on line 4.
'b' button	Puts the *795x* into **EDIT** mode so that you can edit the data on line 2. The data being edited is *left justified* whilst in EDIT mode. (See next section)
'c' button	Puts the *795x* into **EDIT** mode so that you can select from a list of the units in which the data can be displayed. The units are *left justified* whilst in EDIT mode. (See next section)
'd' button	Puts the *795x* into **EDIT** mode so that you can select a status (Set or Live). The status is *left justified* whilst in EDIT mode. (See next section)
STREAM / RUN SELECT	If there is more than one stream (metering-run) **and** there is a number on the far left of display line 4, this button will select another stream (metering-run). The screen will be refreshed with attributes (value, units and status) for that stream (metering-run).
BACK	Returns you to the previous step.
MAIN MENU	Takes you straight to page 1 of the top-level menu.

6.7 Using the buttons to edit information

You can:

- Edit text.
- Select an option from a multiple-choice list.
- Edit numerical information.
- Edit the date and time.

6.7.1 Text editing

Once in **EDIT** mode (see earlier), the buttons that you use to edit text are:

LEFT-ARROW	Moves the cursor to the **left**, along the line of text you are editing.
RIGHT-ARROW	Moves the cursor to the **right**, along the line of text you are editing.
UP-ARROW	This button changes the character at the current cursor position. It scrolls **forwards** through the alphanumeric character set. Stop when the character you want is displayed.
DOWN-ARROW	Changes the character at the current cursor position. It scrolls **backwards** through the alphanumeric character set. Stop when the character you want is displayed.
0 - 9 buttons	Each button enters a single digit.
'b' button	If you are satisfied with the changes you have made, press **b** to accept the changes and go back to VIEW mode. (The **ENTER** button also does this.)

	ENTER	If you are satisfied with the changes you have made, press **ENTER** to accept the changes and go back to VIEW mode. (The '**b**' also does this.)
	CLEAR	This clears a line of text.
	BACK	If you do not want to keep the changes you have made, press the **BACK** button to abandon the changes and go back to **VIEW** mode.
+/-	**PLUS / MINUS**	Toggles between lower and upper case letters.

6.7.2 Multiple-choice option selection

Once in EDIT mode (see earlier), the keys that you use to select from a multiple-choice list are:

Λ	**UP-ARROW**	Scrolls **up** through the available options.
V	**DOWN-ARROW**	Scrolls **down** through the available options.
b	**'b'** button	If editing the data (on display line 2) and you are satisfied with the change you have made, press the **'b'** to accept the change and go back to **VIEW** mode. (Note: The **ENTER** button also does this.)
c	**'c'** button	If editing the measurement unit selection and you are satisfied with the change you have made, press the **'c'** to accept the change and go back to VIEW mode. (Note: The **ENTER** button also does this.)
d	**'d'** button	If editing the status selection and you are satisfied with the change you have made, press the **'d'** to accept the change and go back to VIEW mode. (Note: The **ENTER** button also does this.)
	ENTER	If you are satisfied with the change you have made, press the **ENTER** button to accept the change and go back to VIEW mode.
CLR	**CLEAR**	Restore the previous contents.
	BACK	If you do not want to keep the changes you have made, press the **BACK** button to abandon the changes and go back to VIEW mode.

6.7.3 Numerical editing

Once in EDIT mode (see earlier), the buttons that you use to edit numerical data are:

<	**LEFT-ARROW**	Erases the digit to the **left** of the cursor.
0 : 9	**0 - 9** buttons	Each button enters a single digit.
+/-	**PLUS / MINUS**	This changes the sign of the number. Pressing it will toggle between PLUS and MINUS signs.

DOT	Inserts a decimal point.
EXPONENT	Use this button if you want to show numbers in exponent form.
‘b’ button	If you want to accept the changes you have made, press the **‘b’**. The *795x* will then revert to VIEW mode. (Note: **ENTER** also does this.)
ENTER	If you want to accept the changes you have made, press the **ENTER** key. The *795x* will then revert to VIEW mode. (Note: **‘b’** also does this.)
CLEAR	Clears the line you are currently editing.
BACK	If you do not want to keep the changes you have made, press the **BACK** button to abandon the changes and go back to VIEW mode.

Numerical entry
When you type in a number the first digit appears at the *left* of the display and each successive digit is then positioned to the *right* of the one just entered. A number being entered over-types any existing number.

Parameter identification number (Location ID) entry
These appear on the display in the same way as for numerical entry. However, when you accept the number (by pressing **‘b’** or **ENTER**), the *text descriptor* of the parameter with that particular number appears on line 2. You will encounter this type of ‘pointer’ (indirection) editing if configuring the Multi-view display (see chapter 11).

6.7.4 Date and time editing

The date and time are displayed in the format: dd-mm-yyyy hh:mm:ss. When you edit the date and time, the cursor moves to the right but skips the ‘:’ and ‘-’ characters.

LEFT-ARROW	Moves the cursor to the **left**.
RIGHT-ARROW	Moves the cursor to the **right**.
0 - 9 buttons	Each button enters a single digit.
‘b’ button	If you want to accept the changes you have made, press **‘b’**. The *795x* will then revert to VIEW mode. (Note: **ENTER** also does this.)
ENTER	If you want to accept the changes you have made, press **ENTER**. The *795x* will then revert to VIEW mode. (Note: **‘b’** also does this.)
CLEAR	Restore the previous contents.
BACK	If you do not want to keep the changes you have made, press the **BACK** button to abandon the changes and go back to VIEW mode.

The new date and time is validated. An invalid date and time is causes the message “Bad date/time” to appear on-screen for a few seconds before the previous content is restored.

6.8 The 795x character set

You can use any of the 96 characters shown below as part of your display.

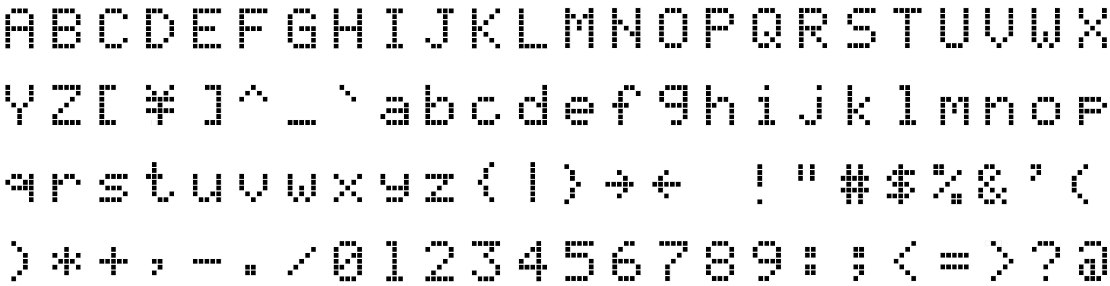


Figure 6.3: The 795x character set

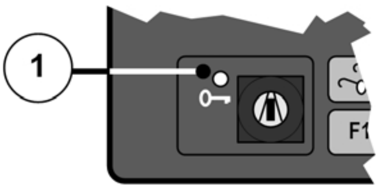
6.9 LED indicators

Security Indicator

This LED shows the present security level of the system.

- RED FLASHING – The instrument is at Calibration level.
- RED – Engineer level: the instrument can be configured.
- ORANGE – Operator level: limits can be changed.
- GREEN – World level: no parameters can be changed.

Note: For more information about these, see Chapter 11.

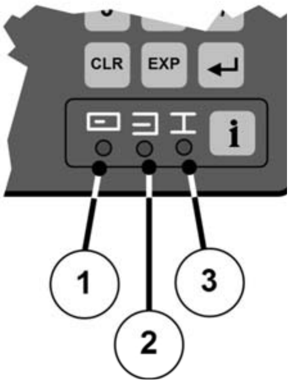


1. Security Level LED.

Figure 6.4: Alarm Indicators

Alarm Indicators

These are the **Input**, **System** and **Limit** alarms. For more information about these, refer to Chapter 8: “Alarms and Events”.



1. System alarm LED.
2. Input alarm LED.
3. Limit alarm LED.

Figure 6.5: Alarm Indicators

6.10 Summary of button functions

The tables here provide a visual summary of the function for each button when in various modes.

BUTTON	WHAT THE BUTTON DOES WHEN... ...moving around the menus	...in VIEW mode	...in one of the following EDIT modes: Text editing	Multiple-choice option selection	Numeric editing	Units selection	Data and time editing	
UP-ARROW	Pages up in a menu (Does nothing if first page already shown).	Does nothing.	●					Scrolls through character set.
				●		●		Scrolls through available options.
					●		●	Does nothing.
DOWN-ARROW	Pages down in a menu (Does nothing if last page already shown).	Does nothing.	●					Scrolls through character set.
				●		●		Scrolls through available options.
					●		●	Does nothing.
MAIN MENU	Goes to the first page of the top-level menu.	Goes immediately to the first page of the top-level menu.	●	●	●	●	●	Does nothing.
BACK	Goes to the first page of the previous menu.	Goes to the first page of the previous menu.	●	●	●	●	●	Cancels changes and reverts to VIEW mode
'a' button	Chooses the menu option on line 1.	Toggles the location ID display on and off.	●	●	●	●	●	Does nothing.
'b' button	Chooses the menu option on line 2.	Goes into EDIT mode.	●	●	●		●	Accept changes and go into VIEW mode.
						●		Does nothing.
'C' button	Chooses the menu option on line 3.	Goes into unit selection editing mode. (See also up and down arrow buttons).	●	●	●		●	Does nothing.
						●		Accept changes and go into VIEW mode.
'd' button	Chooses the menu option on line 4.	Toggles between LIVE and SET (if appropriate).	●	●	●	●	●	Does nothing.
INFORMATION MENU	Goes to a menu for Alarms, Events, Flow Status and Operating Mode.	Goes to a menu for Alarms, Events, Flow Status and Operating Mode.	●	●	●	●	●	Does nothing.
PRINT MENU	Goes to a menu for setting-up and printing reports, plus data archiving.	Goes to a menu for setting-up and printing reports, plus data archiving.	●	●	●	●	●	Does nothing.
MULTI-VIEW DISPLAY	Goes to the defined MULTI-VIEW display	Goes to the defined MULTI-VIEW display	●	●	●	●	●	Does nothing.

Table 6.1: Summary of what the buttons do (Part 1 of 2)

BUTTON	WHAT THE BUTTON DOES WHEN... ...moving around the menus	...in VIEW mode	...in one of the following EDIT modes: Text editing	Multiple-choice option selection	Numeric editing	Units selection	Data and time editing
F1	Software dependent function key F1	Software dependent function key F1	Does nothing.	Does nothing.	Does nothing.	Does nothing.	Does nothing.
ENTER	Does nothing.	Does nothing.	Accept changes and go into VIEW mode.	Accept changes and go into VIEW mode.	Accept changes and go into VIEW mode.	Accept changes and go into VIEW mode.	Accept changes and go into VIEW mode.
LEFT-ARROW	Does nothing.	Does nothing.	Moves the cursor left.	Does nothing.	Erases the last digit.	Does nothing.	Moves the cursor left.
RIGHT-ARROW	Does nothing.	Does nothing.	Moves the cursor right.	Does nothing.	Does nothing.	Does nothing.	Moves the cursor right.
CLEAR (CLR)	Does nothing.	Does nothing.	Deletes character at cursor.	Reverts to original selection.	Clears the line of numerals.	Reverts to original selection.	Restores the previous contents.
DOT	Does nothing.	Does nothing.	Does nothing.	Does nothing.	Inserts a decimal point.	Does nothing.	Does nothing.
PLUS / MINUS (+/-)	Does nothing.	Does nothing.	Changes to upper or lower case.	Does nothing.	Changes the sign of a number.	Does nothing.	Does nothing.
EXPONENT (EXP)	Does nothing.	Does nothing.	Insert a space at the cursor.	Does nothing.	Inserts an exponent.	Does nothing.	Does nothing.
STREAM/RUN SELECT	Does nothing.	Selects another stream/run if more than one is supported	Does nothing.	Does nothing.	Does nothing.	Does nothing.	Does nothing.
0 - 9	Does nothing.	Does nothing.	Enter a digit.	Does nothing.	Enter a digit.	Does nothing.	Enter a digit.

Table 6.2: Summary of what the buttons do (Part 2 of 2)

7. The menu system

7.1 What this chapter tells you

Before you can configure and operate the *795x*, you should have some understanding of how the **menu system** works. The menus are simple and intuitive, so they should present no problems to the average user.

This chapter gives you a **general tour**, showing how to navigate the menu system to find application parameter screens and other types of screen such as for entering passwords.

Note:
The menus and parameters will differ between software versions, and can differ between releases of a software version. Chapter 12 features tables showing the routinely used (operator) parts of the menu system used in your software.

7.2 What the menu system does

The menu system lets you:

- Configure the *795x*.
- Operate it.
- View data and settings stored in the *795x*.
- Edit data stored in the *795x*.

7.3 How the menu system works

When you power-on the *795x*, the menu system appears immediately after the routine Power-On-Self-Test (POST) is completed. If it is the **first power-on** since the software was installed, a screen appears showing the software version number and the issue number e.g. **2550 Iss 1.00.00**. if this is not the case, the screen will be the last visited menu location prior to powering off (or a power failure).

Press the **MAIN MENU** button *once* and **page 1** of the **top-level menu** will appear (see Figure 7.1).

The menu system is a *tree-like* structure that repeatedly *branches* to lower levels until a final screen is reached. Page 1 of a top-level menu shown in Figure 7.1. It comprises four **menu choices** – Flow rates, Flow totals, Density and Viscosity.

Each menu choice has a **description** e.g. “Flow rates” and a **triangular icon** e.g. ▷ alongside to indicate the *type* of menu choice. A non-filled, triangular icon (▷) indicates the menu choice leads to a lower-level menu (sub-menu). A filled, triangular icon (▶) indicates the menu choice leads to a parameter screen.

Note: The menus may be different in your software.

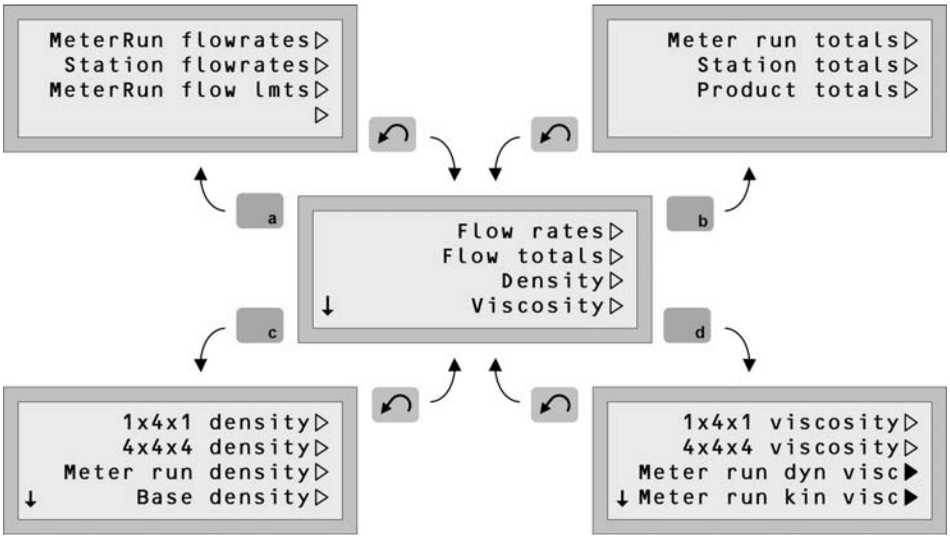
Figure 7.1: page 1 of a top-level menu

Each menu choice is associated with a lettered button on the front panel - **a**, **b**, **c** or **d**. For example, a menu choice on **Display Line 1** is associated with the **a** button. Similarly, a menu choice on Display Line 2 is associated with the **b** button, and so on. If there is no menu choice on a display line, the associated letter button will not do anything.

When you do make a menu choice from a menu using the **lettered** buttons, the display changes to show the selected lower-level menu or a parameter screen.

Figure 7.2 shows an example where pressing the **a** button will lead to a lower-level menu for “Flow rates”. Similarly, the **b** button leads to a lower-level menu for “Flow totals”.

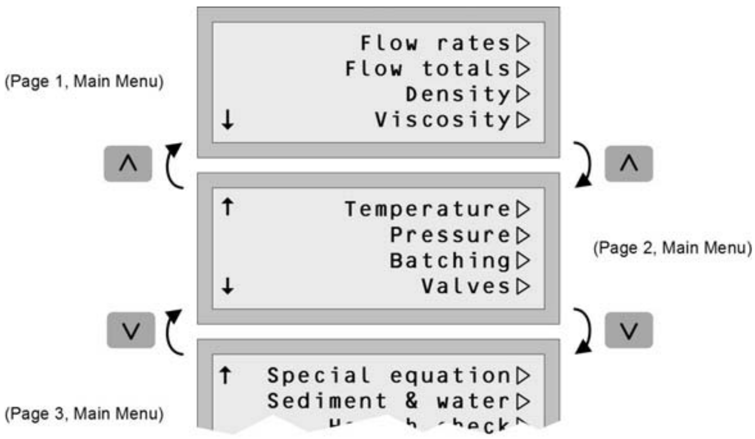
Using the **BACK** button will return you to the *previous* menu level.



Note: The menus may be different in your software.

Figure 7.2: Menu Choice Selection

Where a menu has more choices than can fit on to the 4-line display, the menu comprises of two or more **pages**. Vertical arrow icons appear on the left-hand side of display to indicate there are further pages on the same menu level. Figure 7.3 shows how you can scroll up or down between the pages by using the **UP-ARROW** and **DOWN-ARROW** buttons. These buttons will do nothing unless there is a page to scroll to.

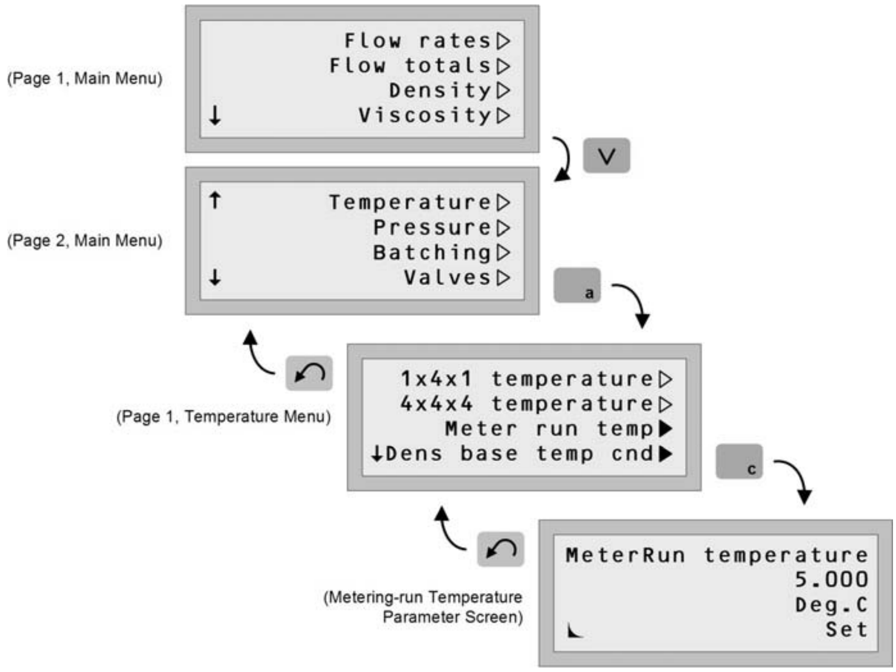


Note: The menus may be different in your software.

Figure 7.3: Pages of a Main Menu

At the lowest levels in each branch of the menu system, there are **parameter screens**. Figure 7.4 shows how to navigate to the **parameter screen** for <MeterRun Temperature>. All parameter screens feature a solid, black, triangular shaped mark in the bottom-left corner of Display Line 4.

Note: Full details about editing parameters can be found in Chapter 6.



Note: The menus may be different in your software.

Figure 7.4: A typical software parameter screen

Returning to the top-level menu again, there are menu choices that are common to all software versions (Figure 7.5). In addition, you'll encounter them in subsequent chapters.

All other menu choices on the Main Menu (e.g. "Flow rates") are for **operators** to quickly find final measurements and other calculation results. Chapter 12 has tables showing these menus in more detail.

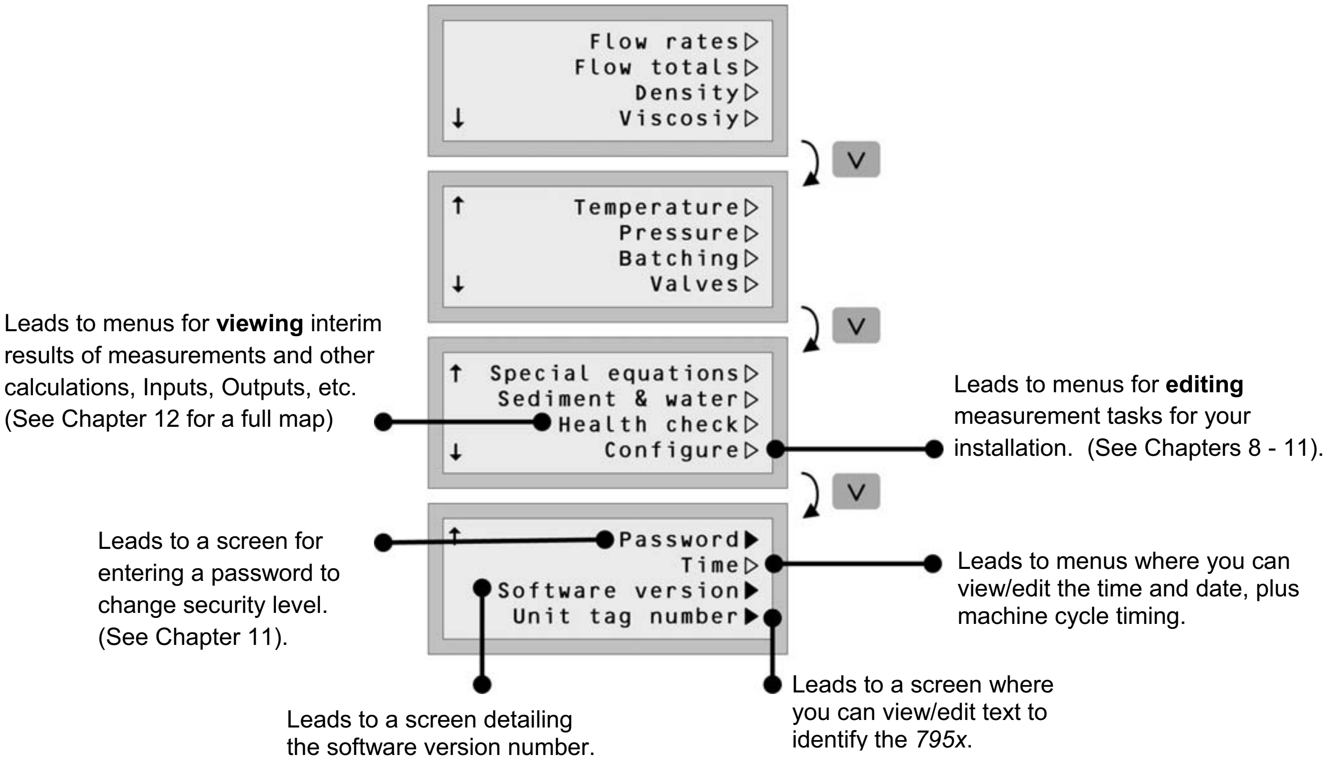


Figure 7.5: Menus common to all software versions

8. Alarms

8.1 Alarms

8.1.1 Alarm types

The types of alarms that are detected and recorded are:

System alarms, caused by one or more of:

- Power failure.
- Battery low (if a battery is fitted).
- Watchdog.
- RAM checksum failure.
- ROM checksum failure.

Input alarms, caused by one or more of:

- Failure of analogue inputs.
- Failure of density transducers.
- Incorrect data has been entered.

Limit alarms, caused by one or more of:

- Limits which you have set.
- Limits defined by the system.

These always result in *two* alarms - one when the change first happens and another when the system returns to its normal state.

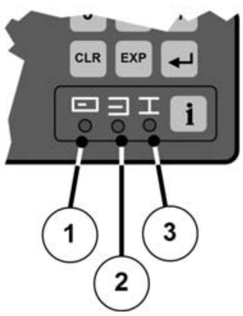
8.1.2 Alarm indicators

The 795x has three LED indicators to show alarm status; one each for Input, System and Limit Alarms.
Each alarm indicator can be in one of three states:

Off The system is working normally.

Flashing An alarm has been received but has not yet been accepted.

On All alarms has been accepted but not yet cleared. The conditions that caused the alarms in the first place may still exist.



1. System alarm **2**. Input Alarm **3**. Limit Alarm

Figure 8.1: Alarm indicators on the front panel

8.1.3 How alarms are received and stored

When a new alarm is received, the appropriate indicator LED on the front panel starts flashing. If the indicator is already flashing because of a previous alarm, it continues to do so. If the indicator is already ON (steady), it starts to flash.

Information about alarms is stored in two logs:

- **The Alarm Status Display** This gives:
  (**1**) a summary of the contents of the Historical Alarm Log
  (**2**) an indication of the current status of the system.

- **The Historical Alarm Log** This contains an individual entry for every alarm stored in the log.

The Historical Alarm Log can store up to 30 entries. When a new alarm is received, one of two things can happen:

If the Historical Alarm Log is NOT full:

An entry for the new alarm is simply added to the list.

If the Historical Alarm Log is full:

It depends on how the system is set up: Either (1) the oldest entry is deleted and the new one is added to the top of the list, or (2) the new alarm is discarded. In either case, the Status Display is updated automatically.

8.1.4 Examining the Alarm Status Display and Historical Alarm Log

Press the **INFORMATION MENU** (**i**) button if you want to examine the Alarm Status Display or the Historical Alarm Log.

- To bring up the **Alarm Status Display**, select the **Alarm Summary** option.
- To bring up the first entry in the **Historical Alarm Log**, select the **Alarm History** option.
- To return to the **INFORMATION MENU** from the two screens , you can use the **BACK** button

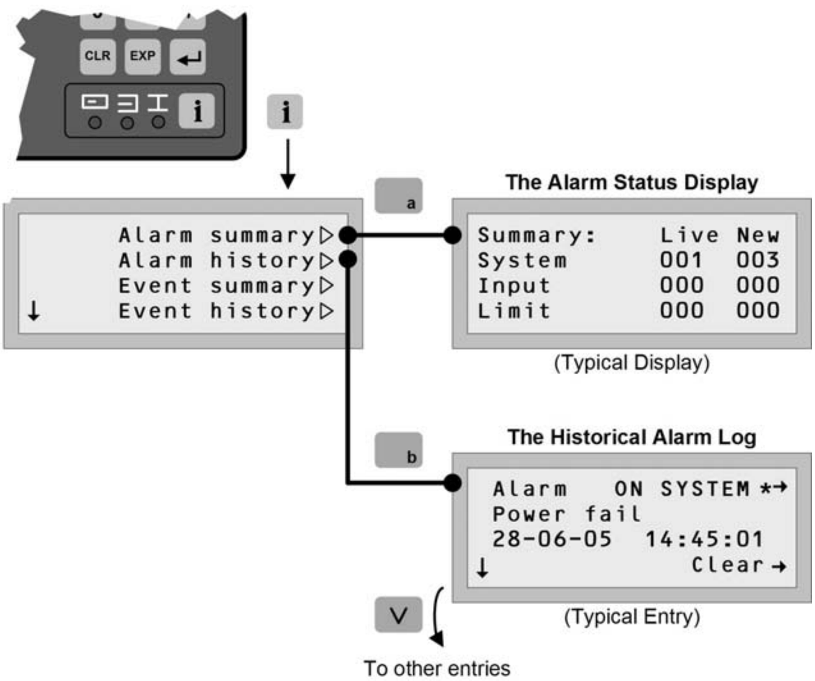


Figure 8.2: How to get to the alarm log

8.1.5 What the Alarm Status Display tells you

A typical **Alarm Status Display** is shown in Figure 8.2. The display lists, for each type of alarm (System, Input or Limit), the number of alarms that are **live** and **new**.

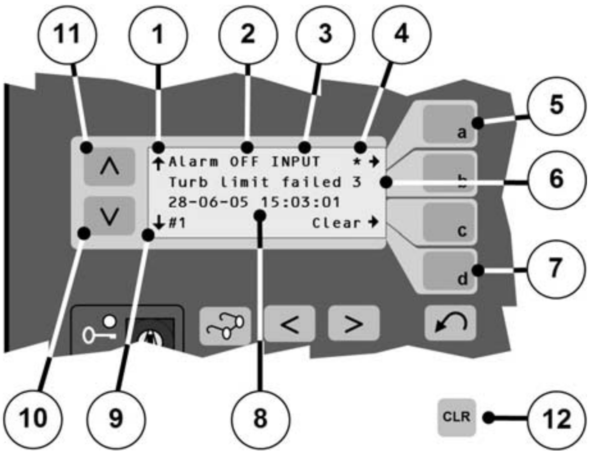
- **New alarms** are alarms that have been received but not accepted.
- **Live alarms** are alarms that refer to conditions still active.

An example of a live alarm is when there is a fault in the system. This produces two alarms - one when the fault first occurs (‘ON’) and the second when it is put right (‘Off’). If only the first alarm of the pair has been received, the alarm is said to be live because the condition still exists.

The number of live alarms tells you how many faults are still active. If you look at the Historical Alarm Log this tells you more about these faults.

8.1.6 What the entries in the Historical Alarm Log tell you

Figure 8.3 shows a typical display and the function of the relevant buttons.



Key to figure:

1. Indicates if there are entries BEFORE this one
2. Alarm is either ‘ON’ (fault occurrence) or ‘OFF’ (fault cured).
3. Type of alarm
4. Indicates alarm not accepted
5. Accept this alarm
6. Alarm description and extra identifier to qualify the alarm
7. Clear this alarm entry
8. Date and time that this alarm (message) was raised.
9. Identifies a metering-run/stream - *not applicable to single meter-run/stream software*
10. Indicates that there are alarm entries AFTER this one
11. Scroll DOWN through the entries
12. Scroll UP through the alarm entries
13. Clear all alarm entries.

Figure 8.3: A typical entry in the log

Each alarm has its own entry in the Historical Alarm Log that tells you:

- **Type of alarm**
  Whether it is a **System alarm**, **Input alarm** or **Limit alarm** and if the alarm is ‘**on’** or ‘**off’**.

- **Extra identifier for the alarm**
  This is not always shown for every entry but, where it is shown, it could be one of the following:

  - **A digit** This indicates the channel number on which the fault occurred.
  - **A letter** **H** and **L** are for high and low Limit alarms, **S** is for a step alarm.

- **Date and time**
  The date is in the format DD-MM-YY and the time HH:MM:SS. These are entered automatically by the system when the alarm is received. The time is accurate to within one second.

- **Acceptance indication**
  This is only shown for those entries that have *not* been accepted. When the entry is accepted, the indicator disappears.

- **Other entries indication**
  An **up-arrow** symbol shows that there are entries *before* the present one, whilst a **down-arrow** symbol shows that there are others *after*. If the entry currently shown is first in the list, there is no up-arrow. If it is last, there is no down-arrow.

- **Description of the alarm**
  This is an abbreviated description of the alarm and should be sufficient to help you trace the cause of the problem. A complete list of alarm messages, and what they mean, is on page 8.3.

8.1.7 Clearing all entries in the Historical Alarm Log

To clear all the alarm entries in the historical log, press the **CLR** button. This clears all entries in the Historical Alarm Log, zeroes the entries in the Status Display and sets all LED indicators to OFF.

8.1.8 Alarm Messages

Alarm message	Type	What it means
AGA8 failed	Input	AGA8 calculation could not be completed due to a problem. Additional alarm message letters: ‘C’=Composition, ‘L’=Line, ‘B’=Base
AGA8 T.P. range	Input	Temperature and pressure are outside the range that can be handled by AGA-8. Additional alarm message letters: ‘L’=Line, ‘B’=Base
Atmos press limit	Limit	[H]igh, [L]ow or [S]tep limit for Atmospheric pressure has been exceeded
Bad gas data	System	Raw gas data is incorrect
Base dens limit	Limit	[H]igh, [L]ow or [S]tep limit for Base Density has been exceeded
Battery failed	System	795x needs a new battery
Battery low	System	795x needs a new battery as soon as possible
Comparison limit	Limit	Either the A or B user alarms are out of limits
Chromat error	Limit	The Chromatograph has indicated that it has an error of some kind.
Chromat slv fail	Limit	MODBUS communications with a Chromatograph (acting as a slave) have failed.
Compress. fail	Limit	Compressibility calculation has not been fully configured.
Database corrupt	System	Notification that the 795x database has been automatically fixed after corruption was detected. Check the configuration in case data has been changed.
DBM bad chksum.	System	The memory checksum has failed. The 795x needs to be re-configured. Additional character that may be seen: ‘V’=Volatile memory, ‘N’=Non-volatile memory (RAM/FRAM)
DBM bad triple	System	Notification that one or more copies of the data were corrupted. This problem is corrected automatically but the configuration needs to be checked. Additional character that may be seen: ‘0’=RAM, ‘1’=NVM-copy1, ‘2’= NVM-copy2, ‘3’=padding, ‘!’=beyond repair

Dens comp. limit	Limit	Comparison limit of density 'A' and 'B' measurements exceeded *Additional alarm message letters:* *'L'=Line density, 'B'=Base density*
Dens temp A limit	Limit	[H]igh, [L]ow or [S]tep limit for DensityA temperature exceeded
Dens temp B limit	Limit	[H]igh, [L]ow or [S]tep limit for DensityB temperature exceeded
Density cal fail	System	A particular density input has not been calibrated. Additional character seen is the channel number.
Gas slave fail	Limit	MODBUS communications with a 795x (configured as a "Gas Slave") have failed.
Line dens limit	Limit	[H]igh, [L]ow or [S]tep limit for line density exceeded
Line temp limit	Limit	[H]igh, [L]ow or [S]tep limit for Line temperature exceeded
LineTxdr Calcfail	Input	A line density calculation failed because of incorrect data
Live CO2 limit	Limit	[H]igh or [L]ow limit for live carbon dioxide exceeded
Live Energy limit	Limit	[H]igh or [L]ow limit for live energy exceeded
Live N2 limit	Limit	[H]igh or [L]ow limit for live nitrogen exceeded
mA input failed	Input	A mA-type analogue input has failed. Additional character seen is the channel number.
mA input no cal	System	A mA-type analogue input is not calibrated. Additional character seen is the channel number.
mA out cal. fail	System	A mA-type analogue output calibration has failed. Additional character seen is the channel number.
mA output failed	System	A mA-type analogue output has failed. Additional character seen is the channel number.
mA output no cal	System	A mA-type analogue output is not calibrated. Additional character seen is the channel number.
Power fail	System	Power supply to the 795x has been interrupted
Pressure limit	Limit	[H]igh, [L]ow or [S]tep limit for Line pressure exceeded
Prt input failed	Input	A PRT input has failed. Additional character seen is the channel number.
Prt no cal	System	A PRT-type analogue input has not been calibrated. Additional character seen is the channel number.
Pulse out limit	Input	Maximum number of pulses exceeded on a particular channel
SG compare limit	Limit	Limit for comparison of SG 'A' and SG 'B' values exceeded
SG limit	Limit	[H]igh or [L]ow limit for specific gravity exceeded
SpEqu1 calc fail	Input	Incorrect data caused Special Equation 1 to fail
SpEqu2 calc fail	Input	Incorrect data caused Special Equation 2 to fail
Std volume limit	Limit	Limit for standard volume exceeded
Timeperiod failed	Input	A time-period input has failed. Additional character seen is the channel number.
Timeperiod glitch	Input	A glitch has occurred on a time-period input.
Timeperiod no cal	System	A time period input is not calibrated
User alarm	Limit	User alarm 'X' or 'Y' activated

9. Additional facilities

9.1 What this chapter tells you

You can also specify features such as:

- Fallback values and modes to be used if live inputs fail.
- Limits which, if exceeded, trigger alarms.
- The units in which the calculations are performed and are displayed.

The following sections give more information about these, and other, topics which relate to the way in which data is processed.

9.2 Selecting units and data formats

You can select the units which the 795x uses for its calculations and in which it displays the data, as well as the formats in which the data is displayed.
You can choose the units and formats for:

- Line density.
- Base density.
- Temperature.
- Pressure.
- Energy(Cv/m).
- Time period input.

A full list of the units (metric and imperial) is given at the end of this chapter. Note that, if you change the units, the values are converted automatically to reflect the change.

9.3 Limits

You can set limits for some parameters so that an alarm is generated if the limits are exceeded.
There are three types of limit:

- **High limit:** The highest value which the parameter can have before an alarm is generated.
- **Low limit:** The lowest value which the parameter can have before an alarm is generated.
- **Step limit:** The greatest allowable step between successive values before an alarm is generated.

The parameters, and the types of limit which you can set for them, are:

- Line density: high, low and step
- Base density: high, low and step
- Line temperature: high, low and step
- Density temperature: high, low and step
- Line pressure: high, low and step
- Alarm X and Y: high and low
- Specific gravity: high, low and step

9.4 Fallback values and modes

A fallback value is used as a temporary substitute for a parameter if a live input (i.e., the transducer, transmitter or wiring), which is normally used to calculate the parameter, should fail.

A fallback must have one of the following modes:

- **None** The system uses whatever value is available for the parameter regardless of whether or not the live input has failed.
- **Last good value** The system uses, for the parameter, the last value prior to failure.
- **Fixed value** The system uses whatever fixed value you have specified for the fallback.

You can set fallback values for:

- Line density.
- Base density.
- Line temperature.
- Line pressure.
- Specific gravity.
- Density temperature.
- Atmospheric pressure.
- CO_2 and N_2.
- Energy (Cv/m).

9.5 Analogue 0% and 100% values

These are values which specify the zero and span of analogue inputs and outputs.

9.6 Live and set data

What are live and set data?
Stored data can be either live or set. **Live data** is continually updated by new data received from transducers or other transmitters. **Set data** is data that you have entered via the keyboard; it does not change unless you enter new data.

Why should I want to set data?
You may want to set data for reasons such as:

- **You want to test the flow computer's programming**

  If you want to test the flow computer's programming it is much easier if you use known, fixed data.
- **You don't want to monitor a particular parameter constantly or don't want to monitor it at all.**

  If a parameter is not likely to change significantly or if it is not important to measure it accurately, you may not want to connect a transducer or transmitter. In this case, set data may be accurate enough for your purposes.
- **A particular transducer or transmitter is out of action.**

  You can temporarily set the data to a fixed representative value until the transducer is repaired or replaced.

9.7 Units which the 795x can display

The 795x can display data values with many different units, as listed in Table 9.1 below. However, when communicating with other devices, the data is always sent using the standard units.

In Table 9.1, the following definitions are used:

- **Standard units:** Units which the 795x displays unless you choose an alternative.
- **Other units:** Units which you can choose instead of the standard.

Note that many of the abbreviations used in the tables are defined in the glossary.

Table 9.1: Units of measurement

Parameter	Default units	Other units available		
Temperature	Deg. C	Deg. F	Kelvin	Ohms
Pressure	bar abs	Pa abs psia kPa guage	KPa abs bar guage MPa guage	MPa abs Pa guage psig
Differential pressure	mbar	bar N/m2 mm Hg psi	Pa kN/m2 in WG	kPa mm WG in Hg
Volume total	m^3	cm^3 litres barrel	 in3 gallon (UK)	 ft3 gallon (US)
Standard volume total	Std m^3	Std. cc Std. in^3 Std. gallon (UK)	 Std. ft^3 Std. gallon (US)	Std. litres Std. barrel
Mass Total	kg	tonne oz g	ktonne lb	Mtonne ton
Energy Total	MJ	GJ Therm	TJ J	BTU kJ
Density	kg/m^3	$tonnes/m^3$ oz/barrel lb/in^3 lb/gallon (UK) tons/barrel g/cc kg/cc	oz/in^3 oz/gallon (UK) lb/ft^3 lb/gallon (US) tons/gallon(UK) g/litre kg/litre	oz/ft^3 oz/gallon (US) lb/barrel $tons/ft^3$ tons/gallon (US) g/m^3
Base density	kg/m^3	*As for density*		
Time	µs	sec day	min	hour
Frequency	Hz	kHz pulse m/s	pulse/ns pulse/s	pulse µ/s pulse/m
Flow meter factor	$pulses/m^3$	$m^3/pulses$	Vol/pulse	Pulse/vol
Gas data	%	PPM	Mole fraction	
Viscosity	cP	Pa.s Reyn	$kgf.s/m_2$ slug/fts	P $lbf.s/ft_2$
Mass rate	kg/hour	*Mass units / time units*		
Volume rate	$m^3/hour$	*Volume units / time units*		
Standard volume rate	$m^3/hour$	*Volume units / time units*		
Energy rate	MJ/hour	*Energy units / time units*		
Calorific value	MJ/m^3	*Energy units / volume units*		

10. Configuring your instrument by using wizards

10.1 What this chapter tells you

This chapter features complete maps of all the configuration wizards. Each map shows all the possible routes through a wizard.

10.2 Wizards: Configuring the easy way

Wizards are configuration tools which are written into the instrument's software. To configure your instrument, just select the wizard which fits your requirements most closely, follow the prompts to supply the information it asks for and then, if necessary, edit the resulting configuration to match your exact needs.

Wizards are easy to use. We recommend that you use them to configure your installation.

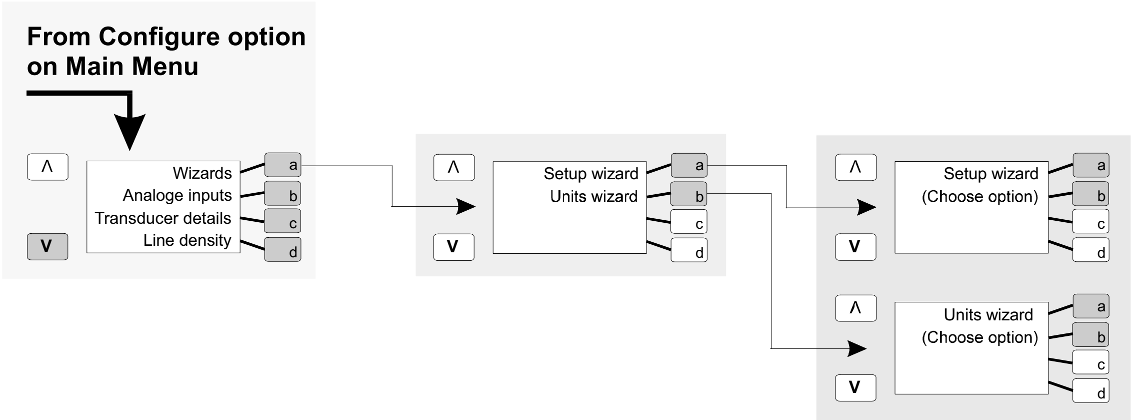
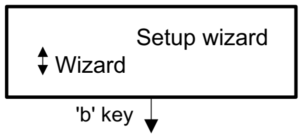


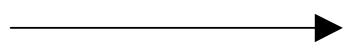
Figure 10.1: How to get to the wizards menu

10.3 Wizard Maps: Conventions used

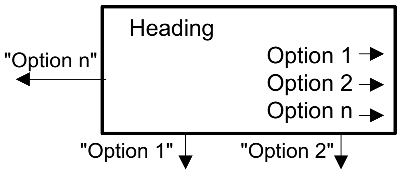
Maps are represented in a form that closely resembles a flow chart. The basic conventions for a wizard map are shown in ***Figure 10.2*** on the page 10.2.



This represents the selection of the wizard. It is the start point for every wizard.
Pressing the 'b' key or the enter key confirms the selection.

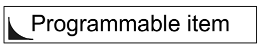


An arrow indicates where a wizard will continue to. It may (or may not) have a label to identify a particular path the wizard is taking



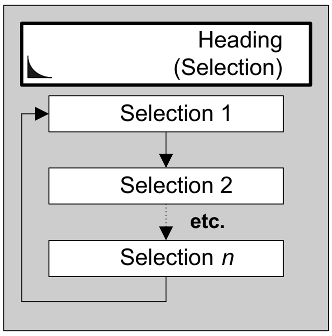
This format indicates a situation where there are two or more options. Choosing any option herewill determine the subsequent path taken by the wizard.

Note that all of the options are always shown in this box. However, the 795x splits options into pages.



An item prompt that appears with the name of the item along with programmable properties - a value, units of measurement and present status. Edit properties and then press the enter key for wizard to continue.

An item prompt with a dotted outline will not always appear. A note alongside states the condition needed for it to appear.

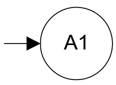


The shaded areas indicate a situation where there are two or more options. Choosing an option here may influence the subsequent path taken by the wizard.

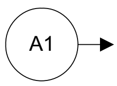
Pressing the 'b' key, when this screen first appears, starts the selection process. The up / down arrow keys cycle through available options.

Pressing the enter key confirms the option displayed as the one chosen. Pressing enter a second time makes the wizard continue.

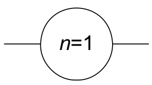
The wizard selection screen is always shown after exiting a wizard



Route will be continued where there is a unique connector with a matching code. Note that the letter in the code is unique to a wizard - *A* is used for the Flow meter wizard (Orifice route).



Route continues from a connector with a matching code. The letter in the code is unique to a wizard -*A* is used for the Flow meter wizard (Orifice route).



This provides information for a prompt that follows. For example, in the Line Density wizard, the value of*n* will be seen to complete a PTZ descripor. PTZ*n* will be PTZ 1 when *n*=1. PTZ *n* will be PTZ 2 when *n*=2.

Figure 10.2: Key to wizard map conventions

10.4 Quick-start Guide (Set-up Wizards)

Wizard	Measurement Task	Page
Density 1	• Gas density measurement (nominated as density 'A') from a single transducer that is connected to "Density input 1".	10.6
Density 2	• Gas density measurement (nominated as density 'B') from a single transducer that is connected to "Density input 1".	10.8
Density 1 & 2	• Gas density measurements (nominated as density 'A' and density 'B') from two transducers that are connected to "Density input 1" and "Density input 2".	
SG 1	• Specific gravity measurement (nominated as SG 'A') from a single transducer that is connected to "Density Input 3".	10.10
SG 2	• Specific gravity measurement (nominated as SG 'B') from a single transducer that is connected to "Density Input 4".	10.11
SG 1 & 2	• Specific gravity measurements (nominated as SG 'A' and SG 'B') from two transducers that are connected to "Density input 3" and "Density input 4"	10.12
Line density	• Density 'A' • Density 'B'	10.13
Base density	• Base density 'A' • Base density 'B'	10.16
Specific gravity	• SG 'A' • SG 'B'	10.18
Temperature	• Line temperature • Density temperature 'A; • Density temperature 'B'	10.20
Pressure	• Line pressure	10.22
Transmitters	• Live nitrogen measurement from an analogue input • Live carbon dioxide measurement from an analogue input • Live energy measurement from an analogue input	10.24
Special Calc.	• Special equations 1 and 2	10.27
Analogue outputs	•	10.28
Alarms	• User defined alarms	10.29
Multi-view	• Multi-page multi-view	10.30
Full Setup	• A collection of wizards for configuring a whole system	10.31

10.5 Set-up Wizard Selection Map

After using the menu to arrive at the wizard sub-menu, as shown earlier in ***Figure 10.1***, a wizard option can be chosen.

Selection Procedure	1. Press the **b-button** to begin the selection process. 2. Use the **up/down arrow** buttons to cycle through all the available wizard options. 3. Press either the **b-button** or the enter button to select the wizard option that presently appears on the 795x display. 4. Examine and then follow directions provided alongside the prompt of the selected wizard option,

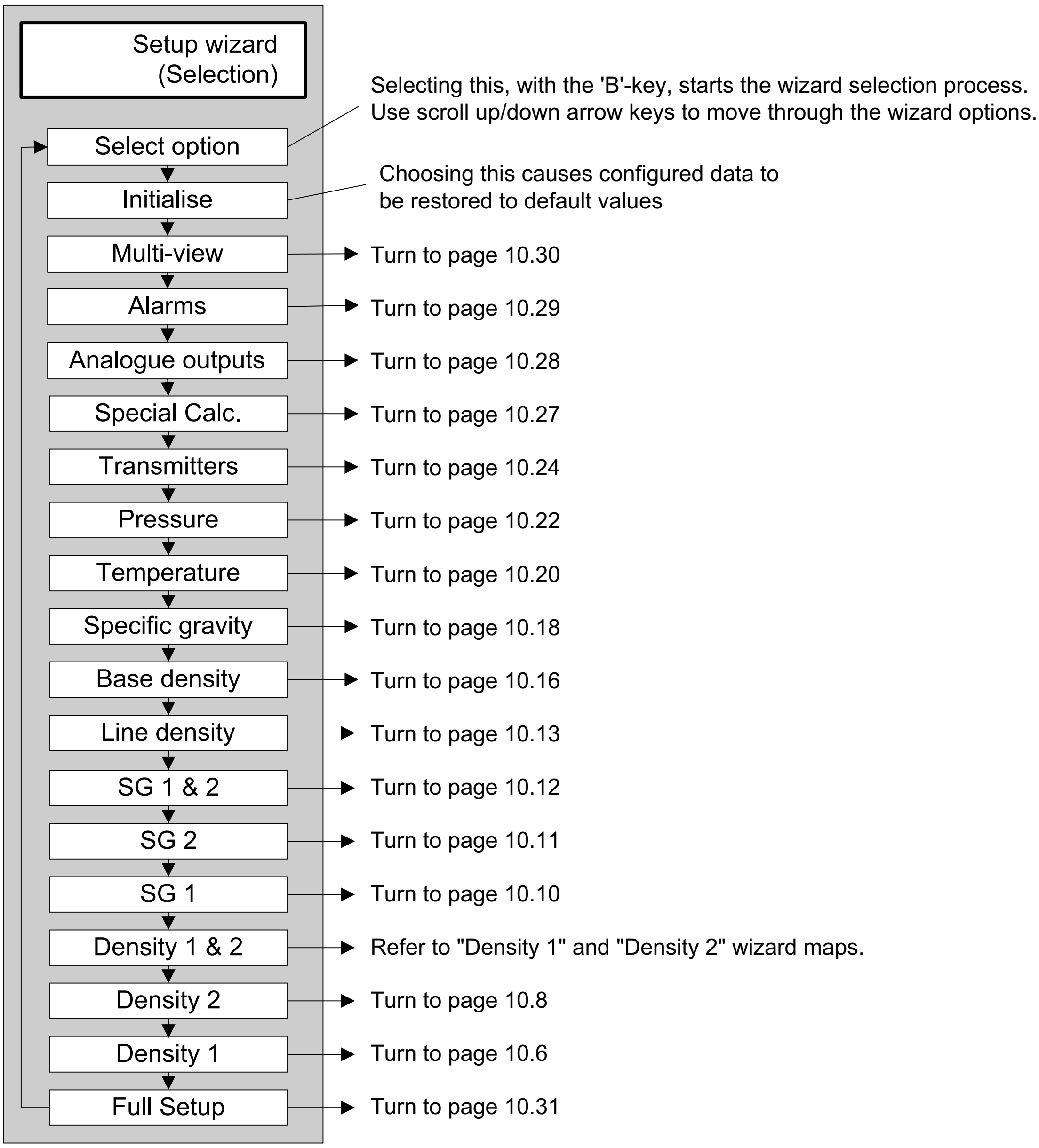


Figure 10.3: Set-up Wizard Selection

10.6 Units Wizard Selection Map

After using the menu to arrive at the units wizard sub-menu, as shown earlier in **Figure 10.1**, a wizard option can be chosen.

Selection Procedure	1. Press the **b-button** to begin the selection process. 2. Use the **UP/DOWN ARROW** buttons to cycle through all the available unit wizard options. 3. Press either the **b-button** or the **ENTER** button to select the unit wizard option that presently appears on the 795x display.

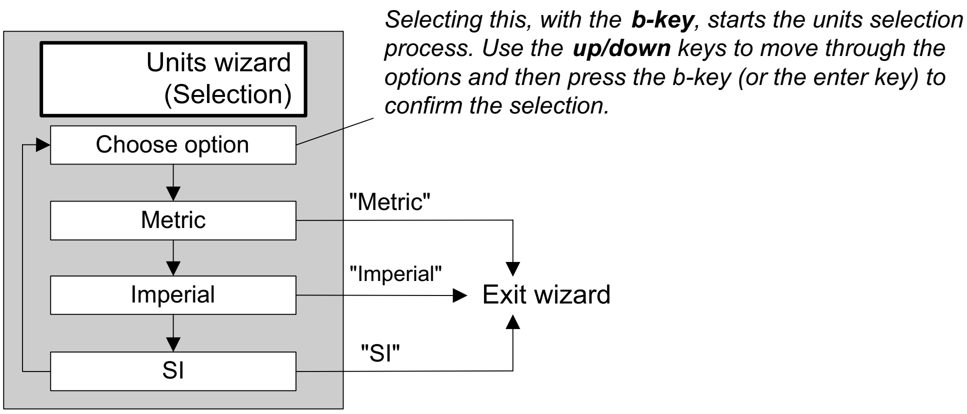
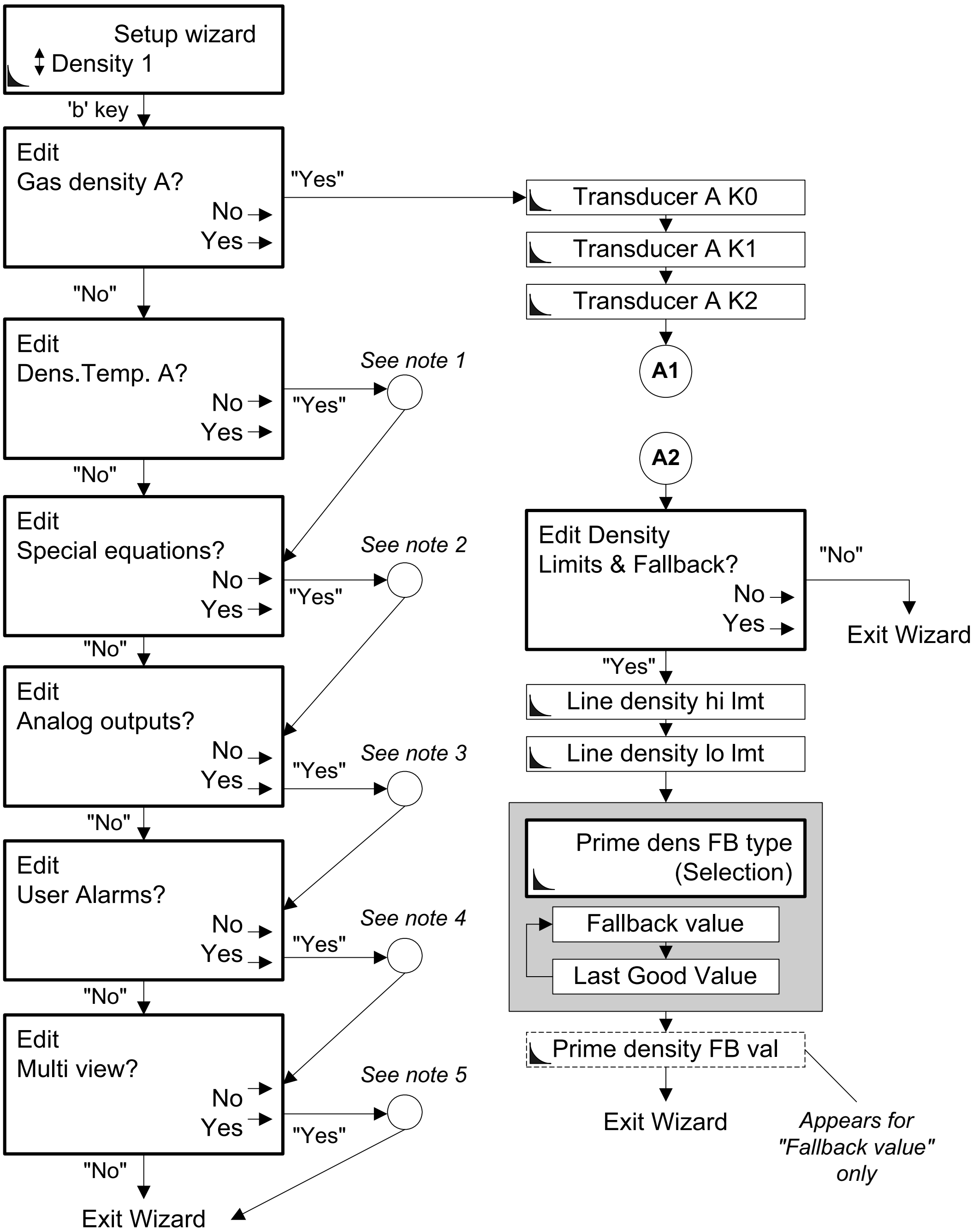


Figure 10.4: Units Wizard Selection

10.7 Density 1 application wizard



Wizard Map Notes:

(1) Route detours to a "Density Temp. A?" sequence (as seen in the "Temperature" wizard map) before continuing.

(2) Route detours to a "Special Equation" wizard map sequence before continuing.

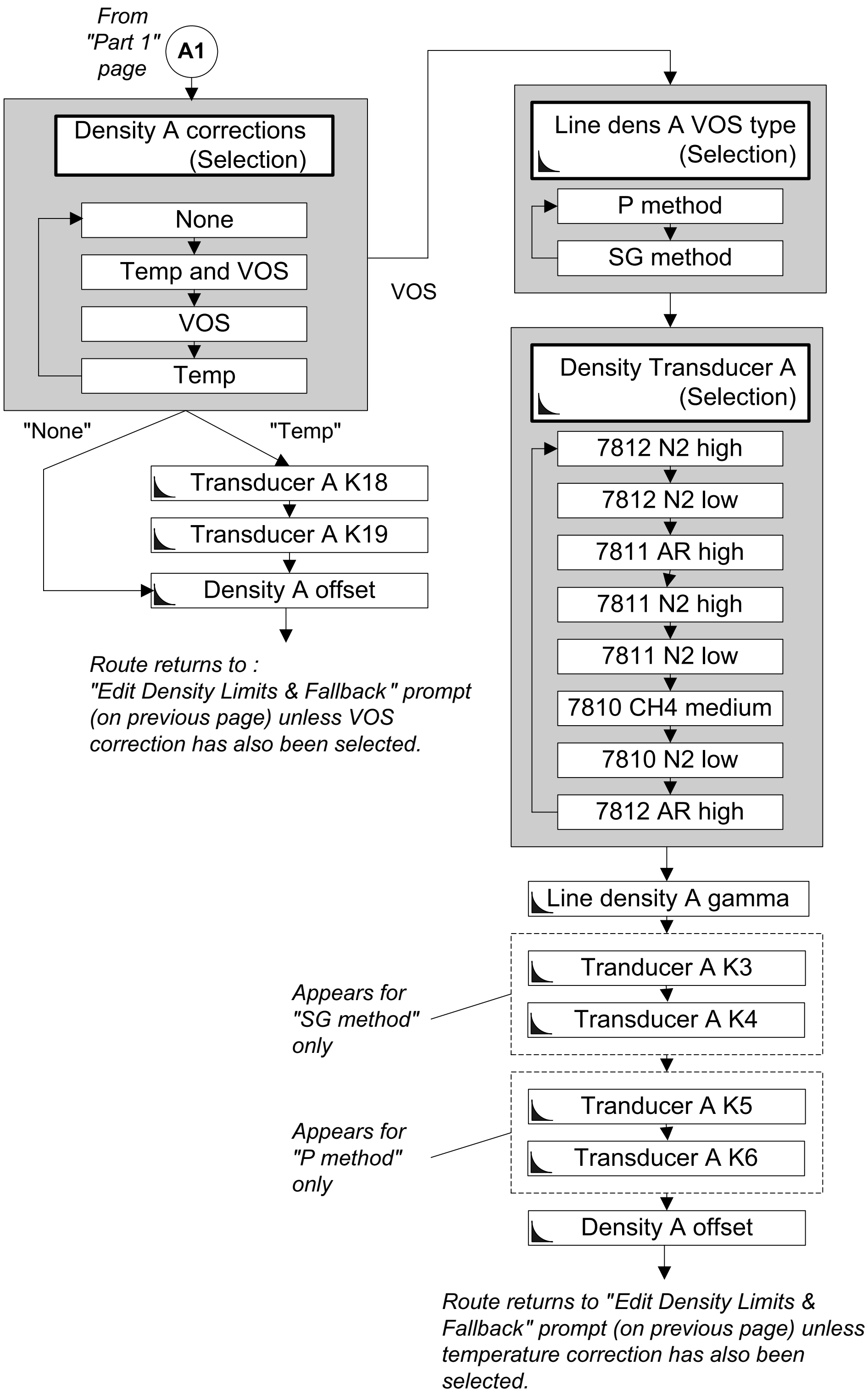
(3) Route detours to an "Analogue output" wizard map sequence before continuing.

(4) Route detours to a "User Alarm" wizard map sequence before continuing.

(5) Route detours to a "Multiview" wizard map sequence before continuing.

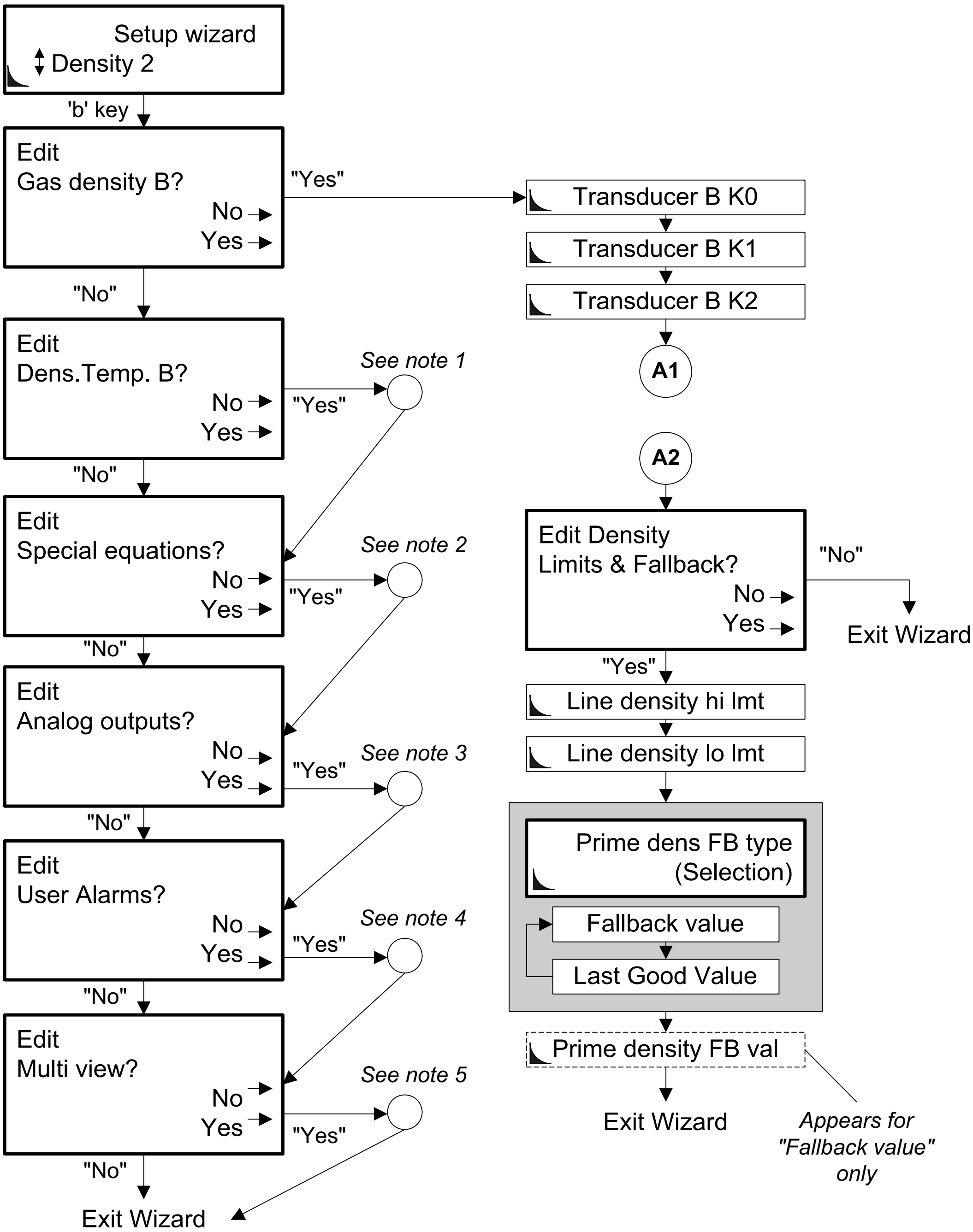
"Density 1" Wizard Map - Part 1 of 2

Temperature & VOS Correction Sequences



"Density 1" Wizard Map - Part 2 of 2

10.8 Density 2 application wizard



Wizard Map Notes:

(1) Route detours to a "Density Temp. B?" sequence (as seen in the "Temperature" wizard map) before continuing.

(2) Route detours to a "Special Equation" wizard map sequence before continuing.

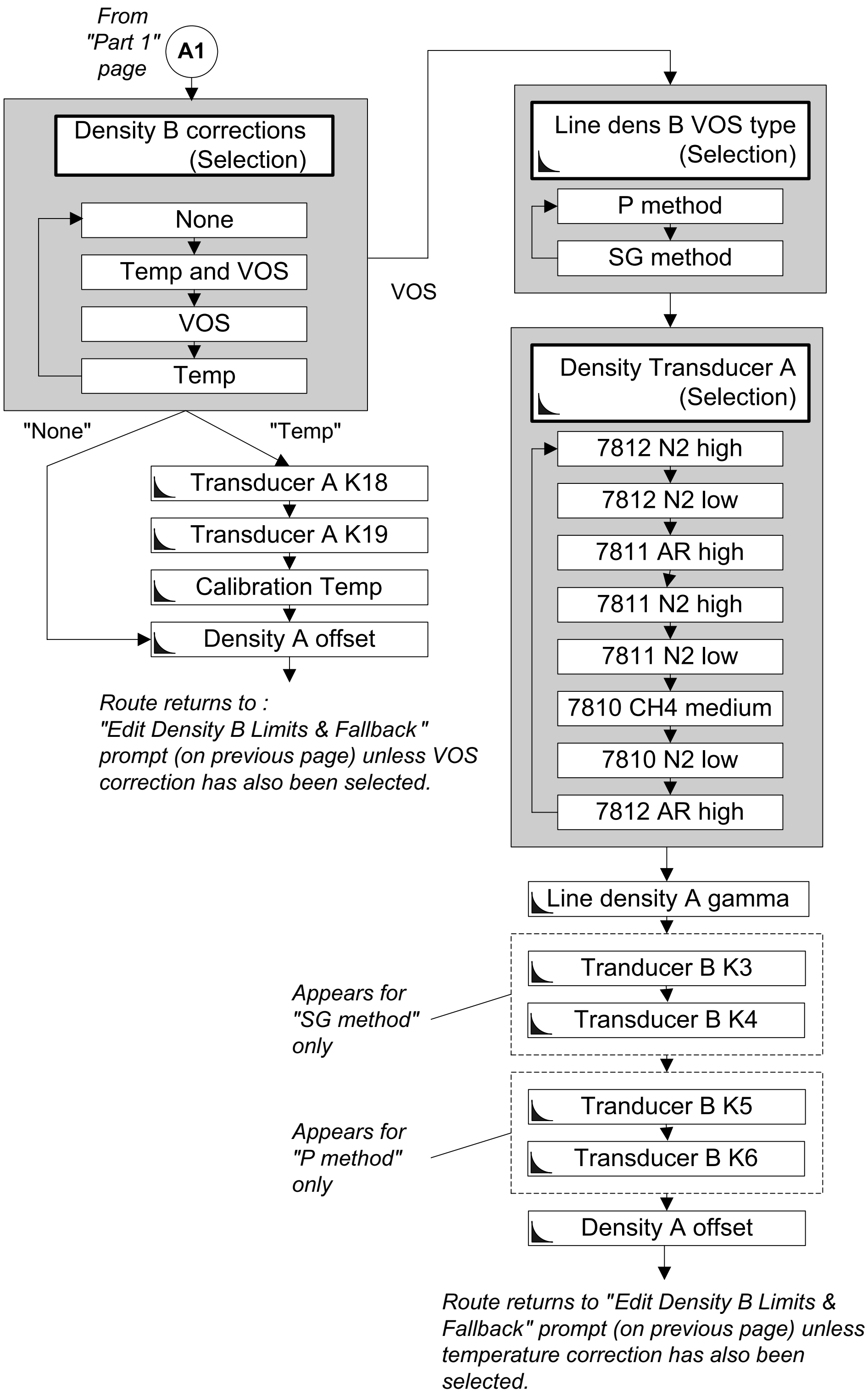
(3) Route detours to an "Analogue output" wizard map sequence before continuing.

(4) Route detours to a "User Alarm" wizard map sequence before continuing.

(5) Route detours to a "Multiview" wizard map sequence before continuing.

"Density 2" Wizard Map - Part 1 of 2

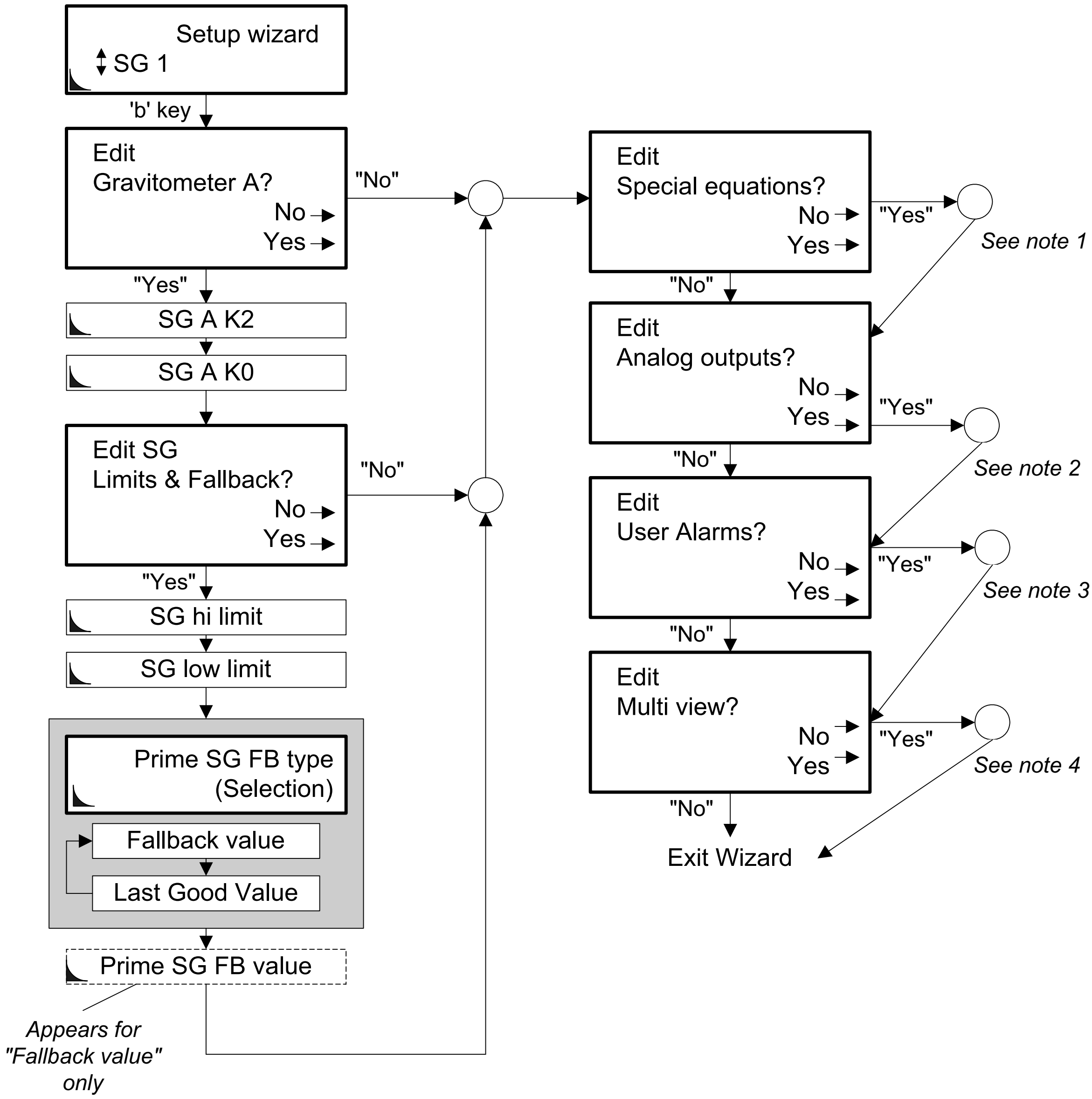
Temperature & VOS Correction Sequences



"Density 2" Wizard Map - Part 2 of 2

10.9 SG-1 Application Wizard

This wizard can be used to configure a system that has a 3096 gas specific gravity transducer connected to “Density input 3”. Special equations, analogue outputs, user alarms and multi-view can also be configured here.



Wizard Map Notes:

(1) Route detours to the "Special Equation" wizard sequence before continuing.

(2) Route detours to the "Analogue output" wizard sequence before continuing.

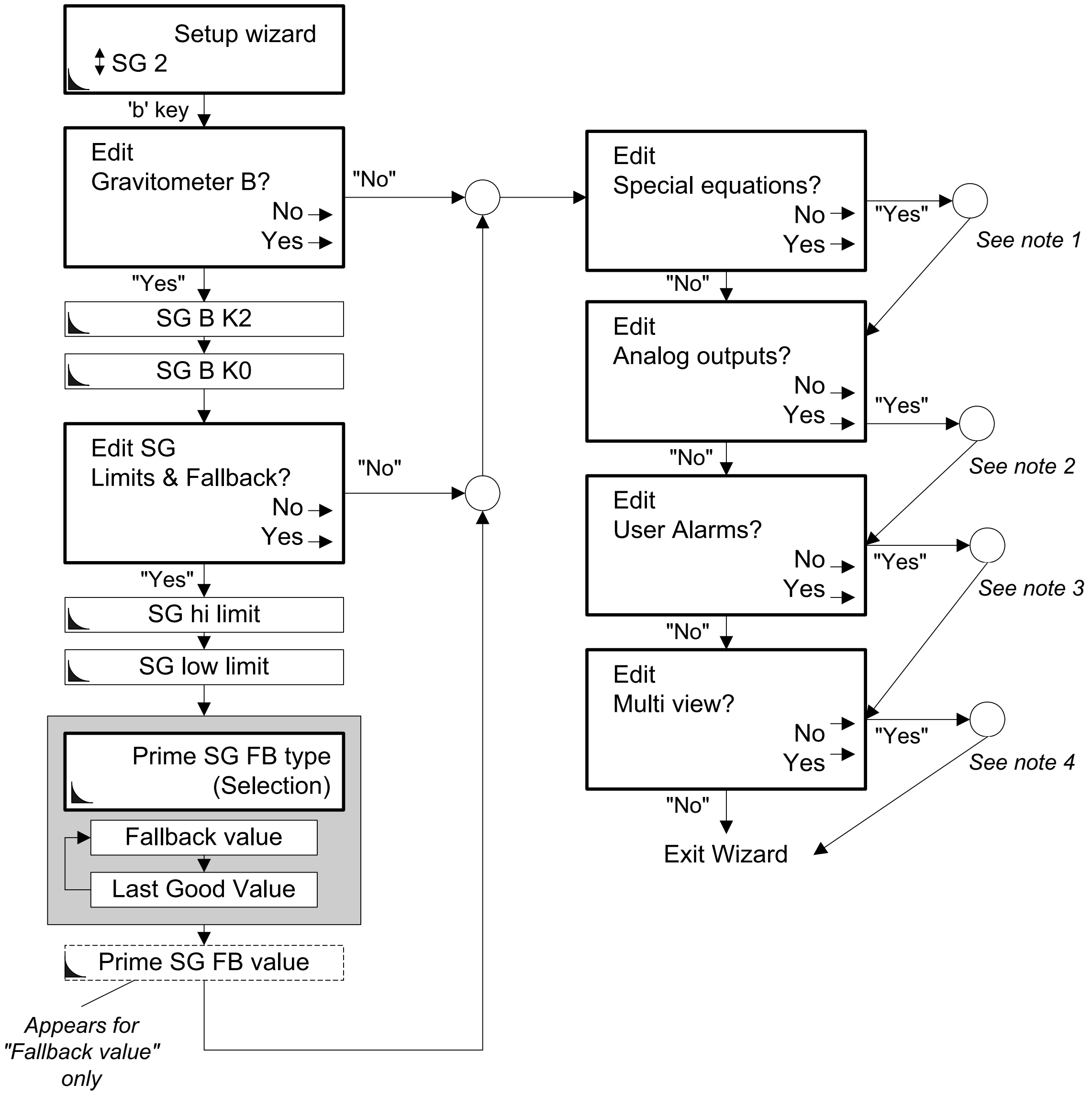
(3) Route detours to the "User Alarm" wizard sequence before continuing.

(4) Route detours to the "Multiview" wizard sequence before continuing.

“SG1” Application Wizard Map

10.10 SG-2 Application Wizard

This wizard can be used to configure a system that has a 3096 gas specific gravity transducer connected to "Density input 4". Special equations, analogue outputs, user alarms and multi-view can also be configured here.



__Wizard Map Notes__:

(1) Route detours to the "Special Equation" wizard sequence before continuing.

(2) Route detours to the "Analogue output" wizard sequence before continuing.

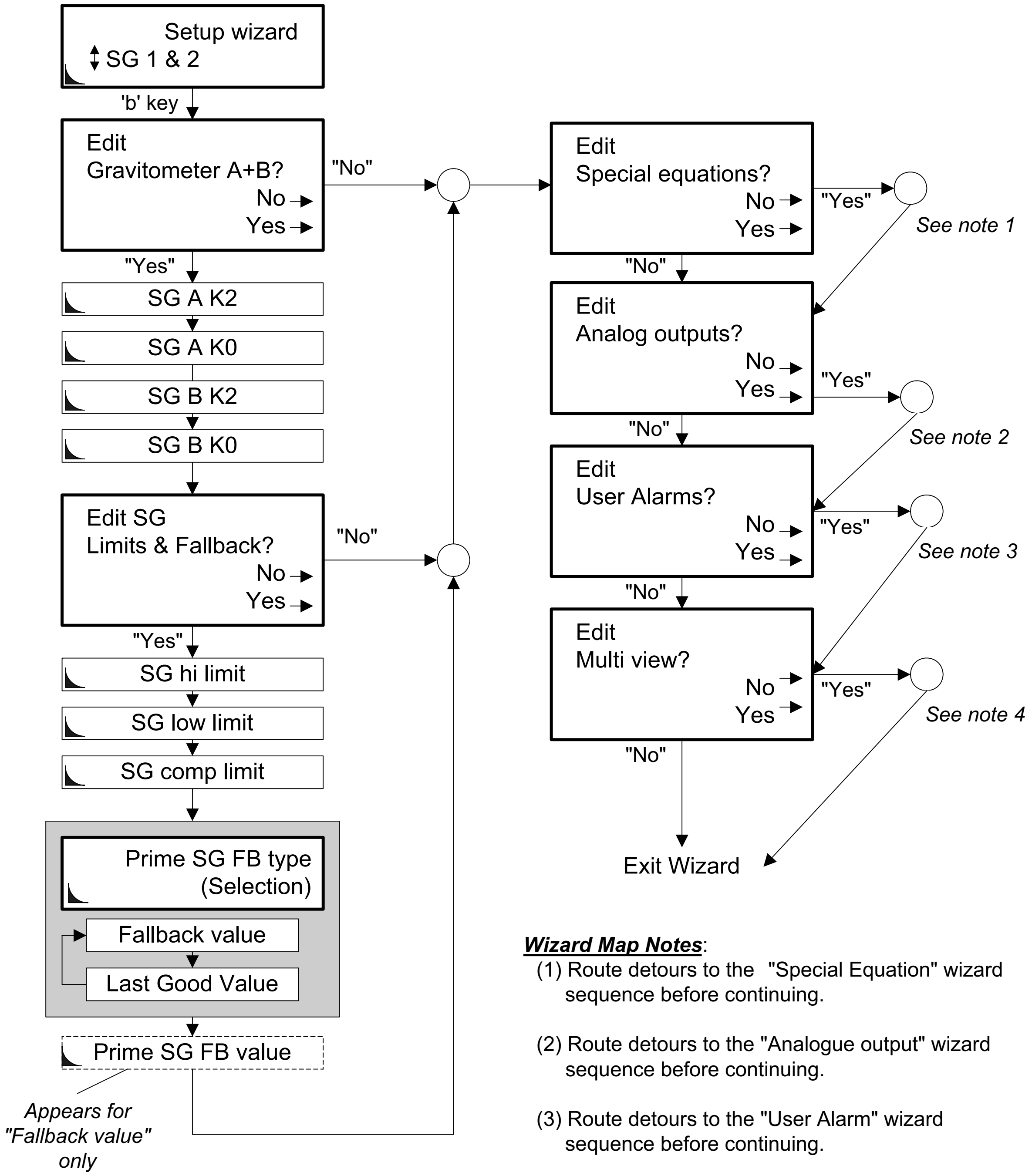
(3) Route detours to the "User Alarm" wizard sequence before continuing.

(4) Route detours to the "Multiview" wizard sequence before continuing.

"SG2" Application Wizard Map

10.11 SG-1&2 Application Wizard

This wizard can be used to configure a system that has 3096 gas specific gravity transducers connected to “Density input 3” and “Density input 4”. Special equations, analogue outputs, user alarms and multi-view can also be configured here.



Wizard Map Notes:

(1) Route detours to the "Special Equation" wizard sequence before continuing.

(2) Route detours to the "Analogue output" wizard sequence before continuing.

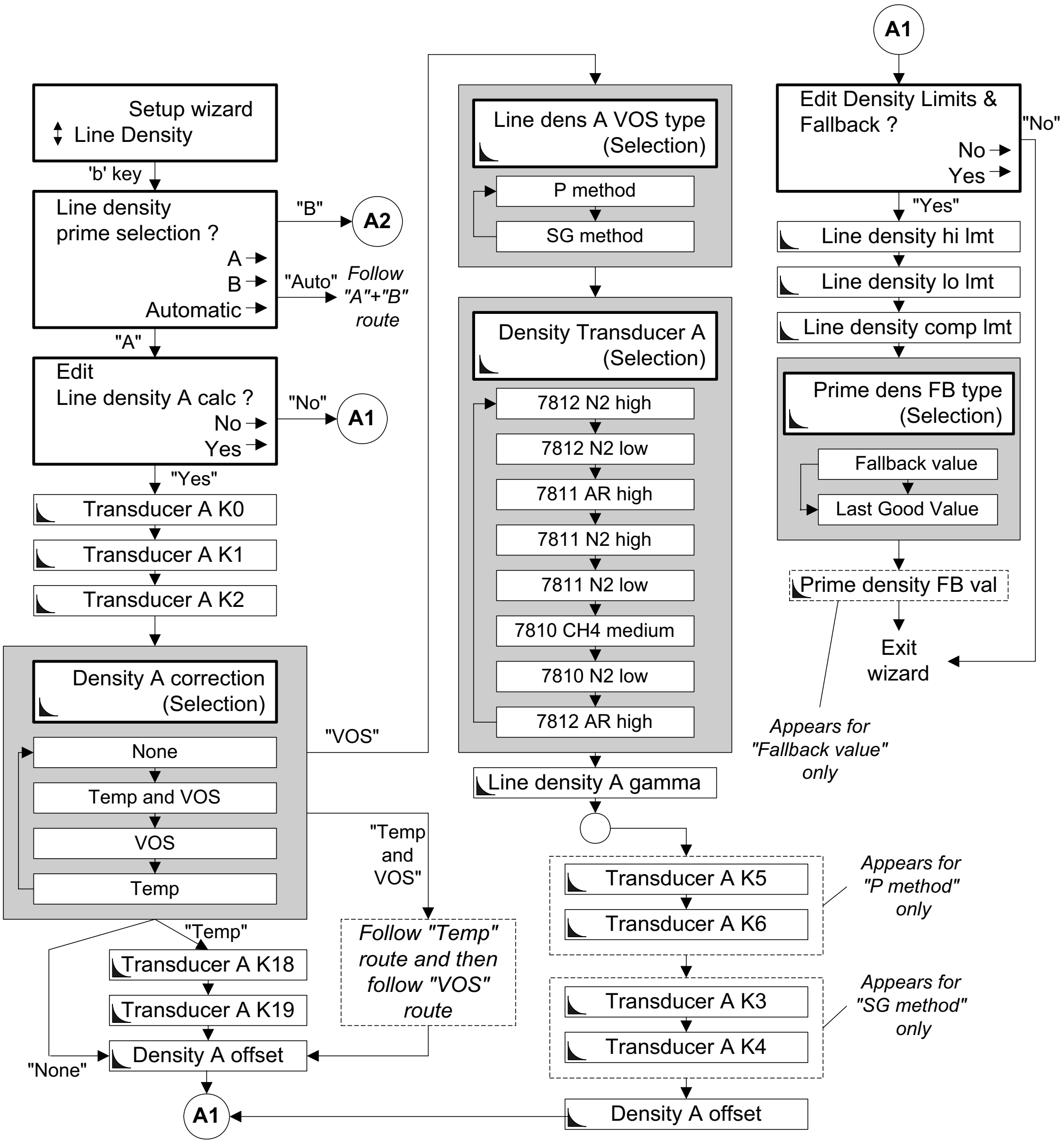
(3) Route detours to the "User Alarm" wizard sequence before continuing.

(4) Route detours to the "Multiview" wizard sequence before continuing.

“SG1&2” Application Wizard Map

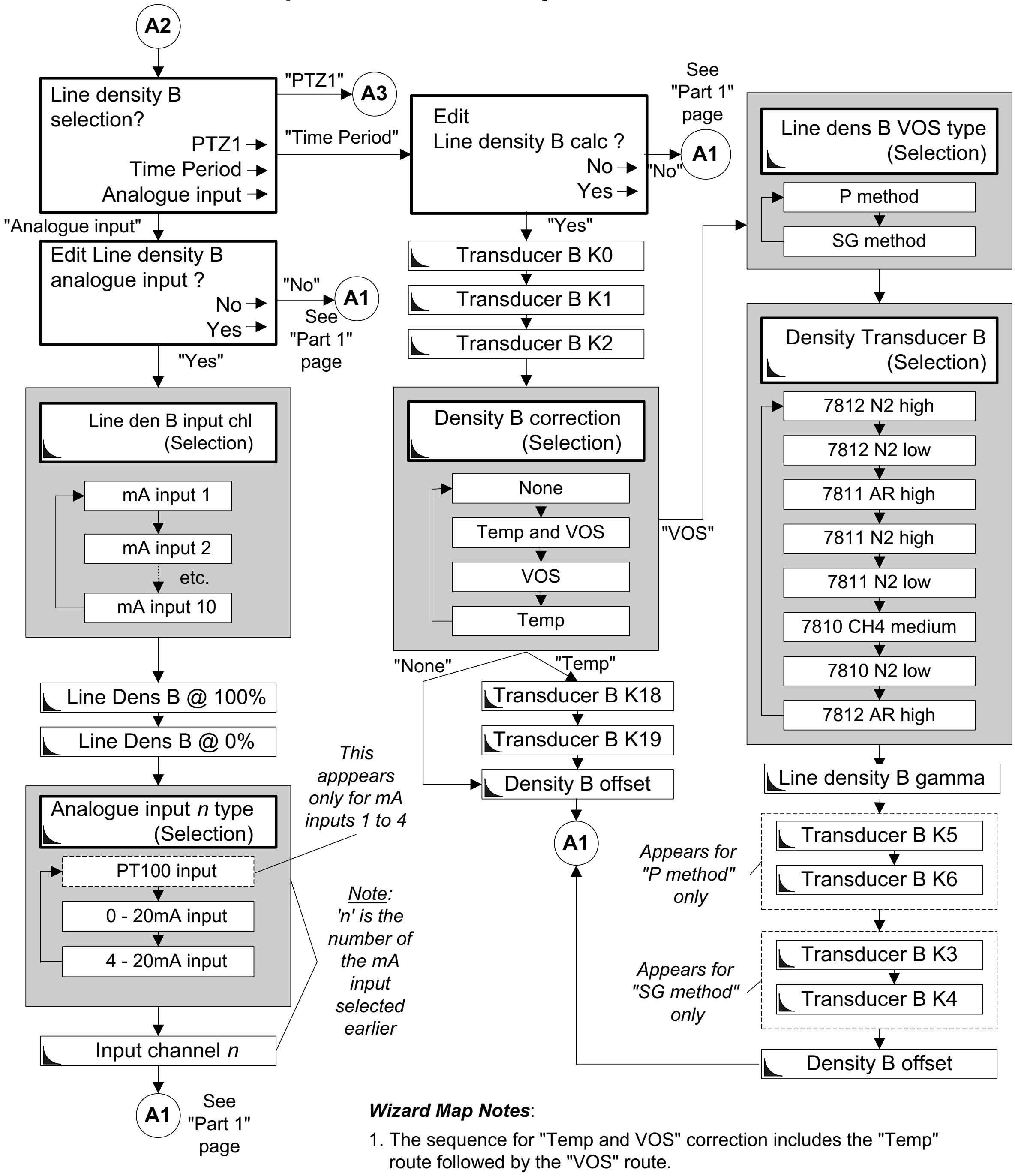
10.12 Line density wizard

This wizard configures the 795x for getting line density 'A' and/or line density 'B' data.



"Line density" Wizard Map - Part 1 of 3

Sequence : Line density 'B' measurement



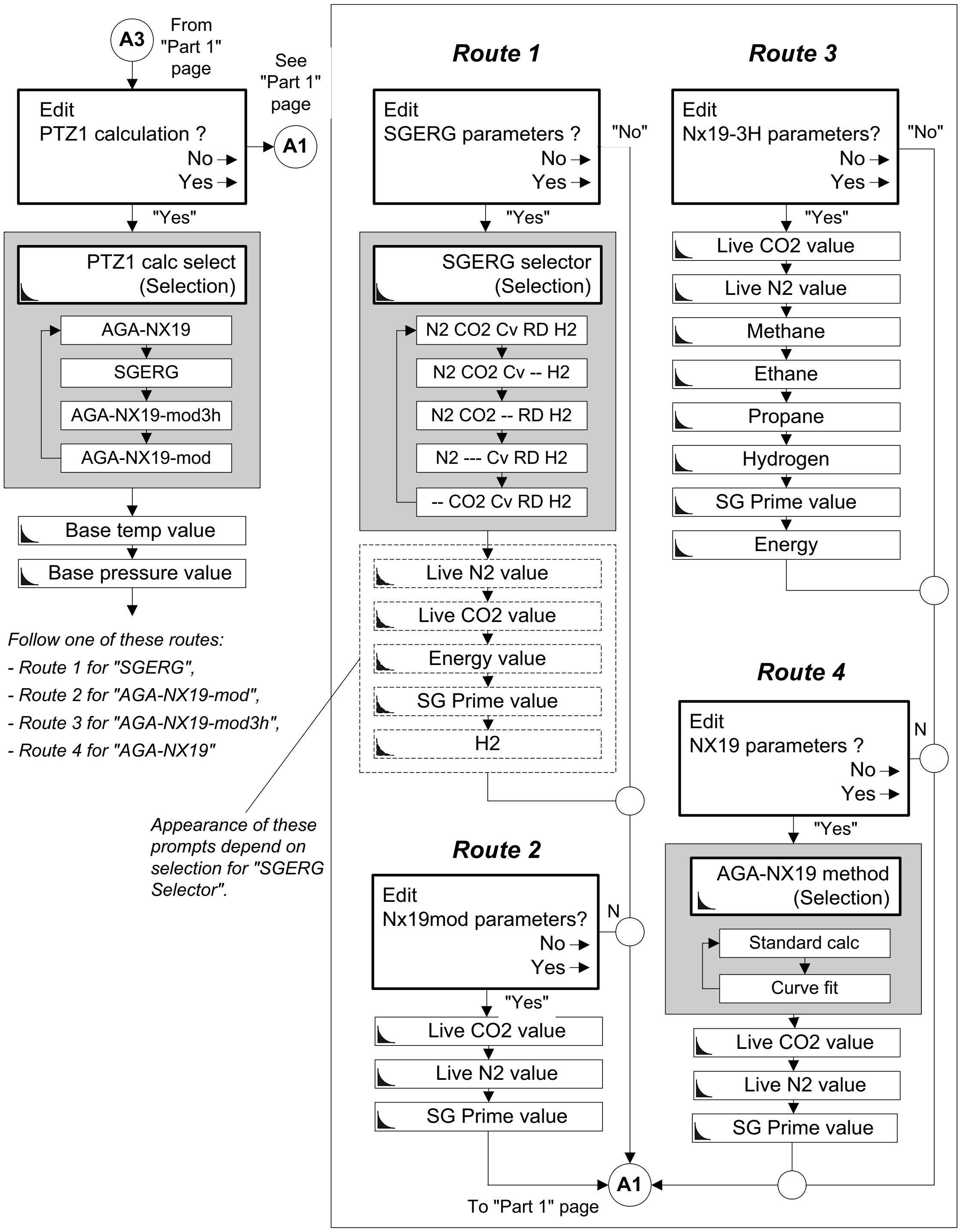
Wizard Map Notes:

1. The sequence for "Temp and VOS" correction includes the "Temp" route followed by the "VOS" route.

2. *Density B offset* appears after all sequences for the selected corrections have been completed.

"Line density" Wizard Map - Part 1 of 3

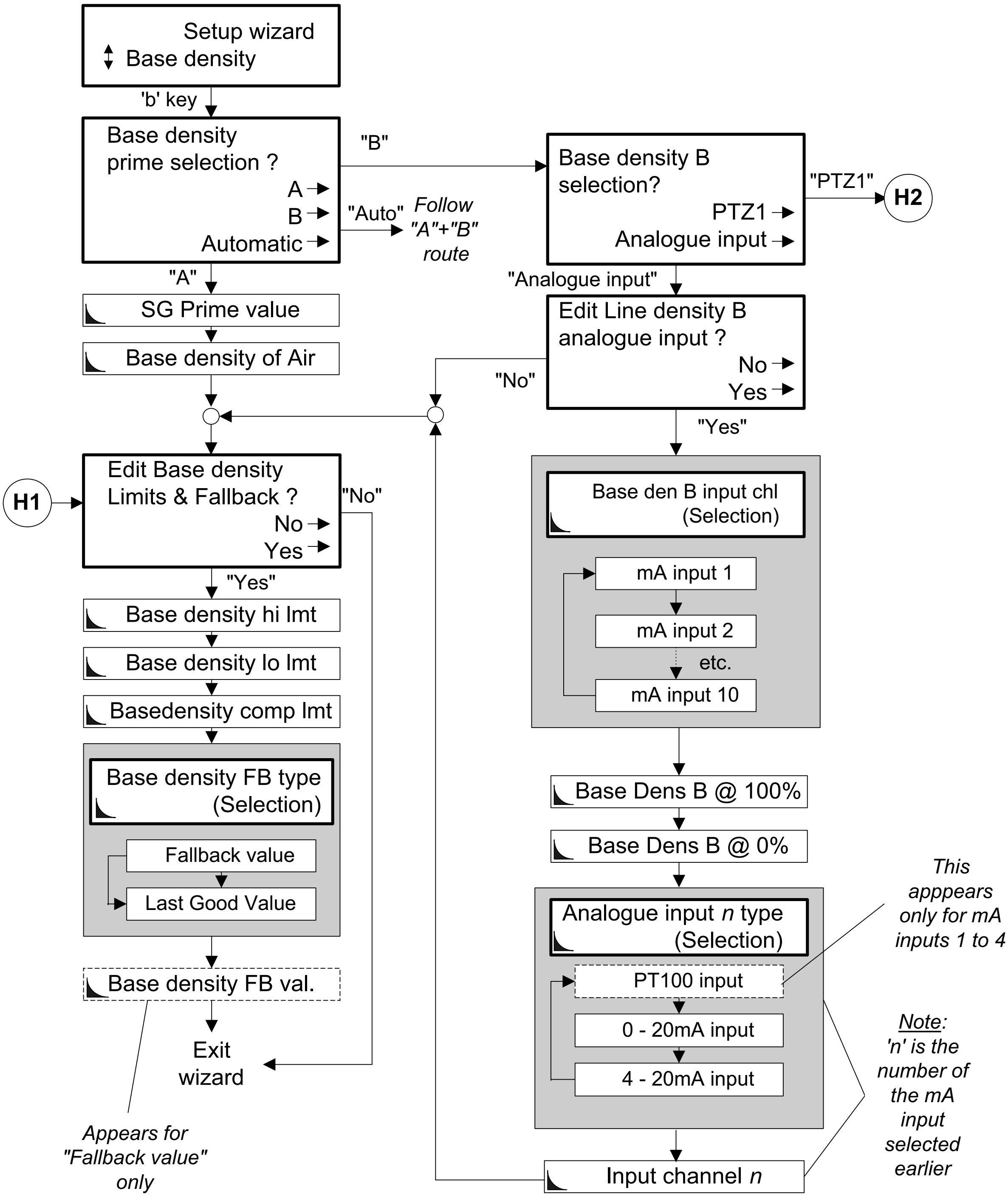
Sequence : Line density 'B' measurement using PTZ1 method



"Line density" Wizard Map - Part 3 of 3

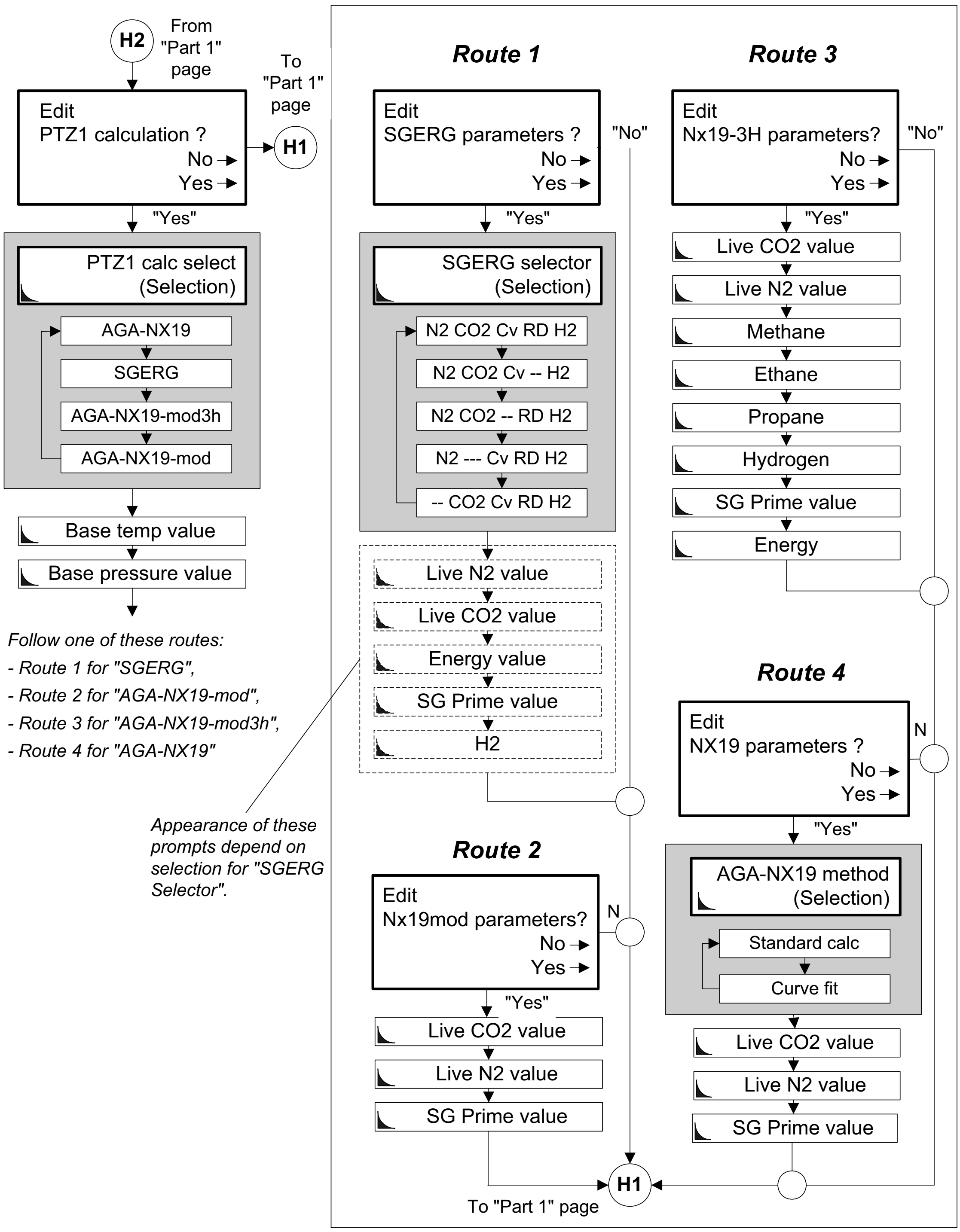
10.13 Base density wizard

This wizard configures the 795x for getting base density ‘A’ and/or base density ‘B’ data.



“Base density” Wizard Map - Part 1 of 2

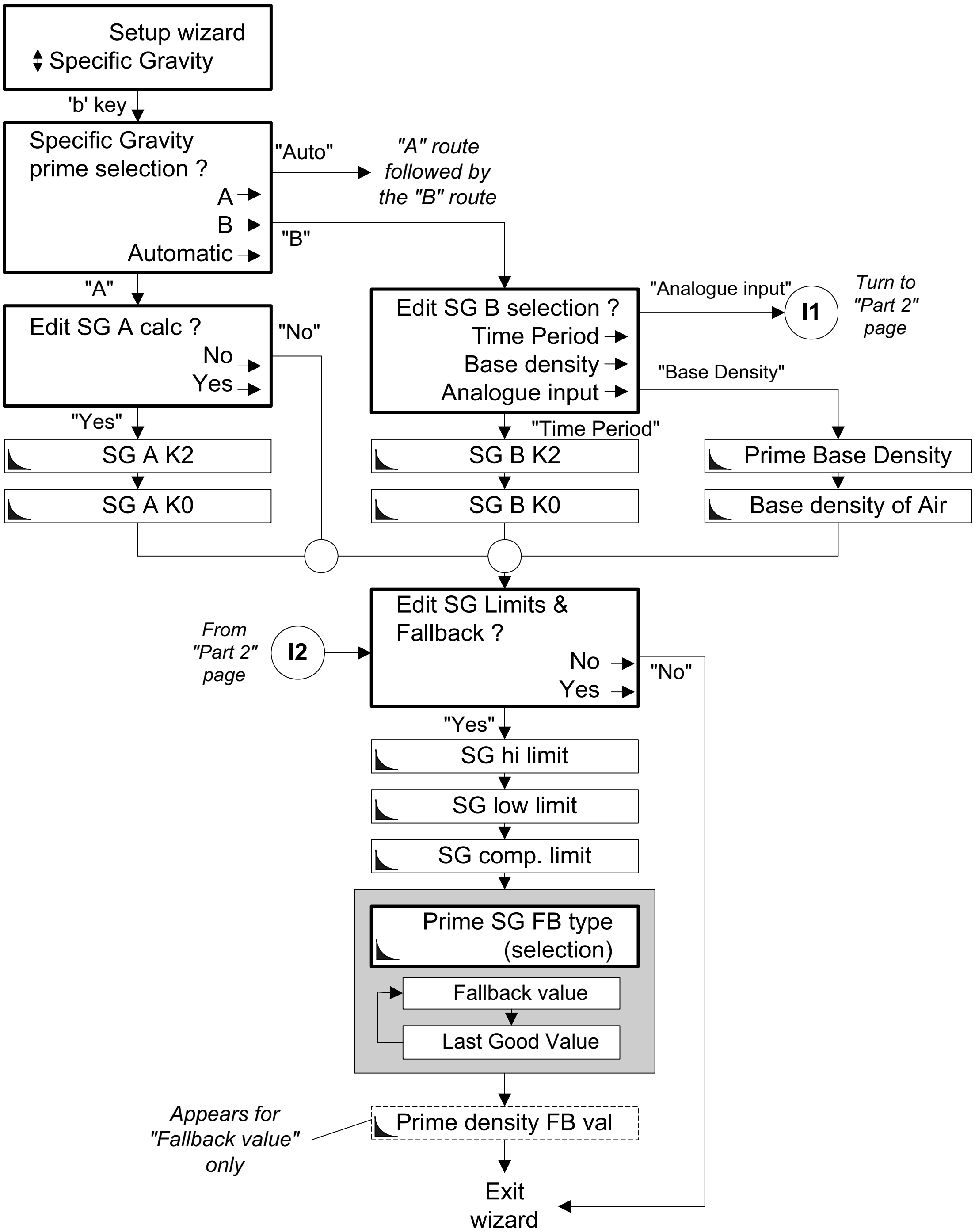
Sequence : Base density 'B' measurement using the PTZ1 method



"Base density" Wizard Map - Part 2 of 2

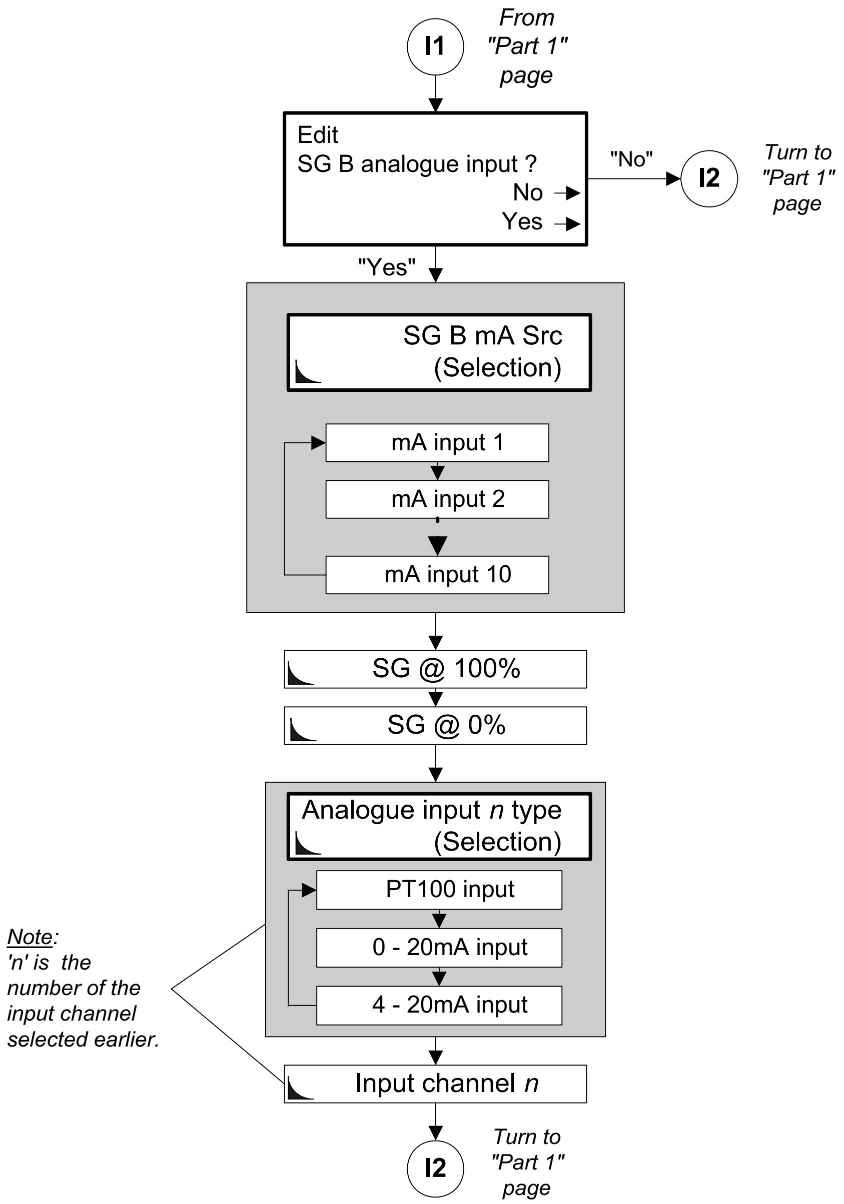
10.14 Specific gravity wizard

This wizard configures the 795x for getting specific gravity ‘A’ and/or specific gravity ‘B’ data.



“Base density” Wizard Map - Part 1 of 2

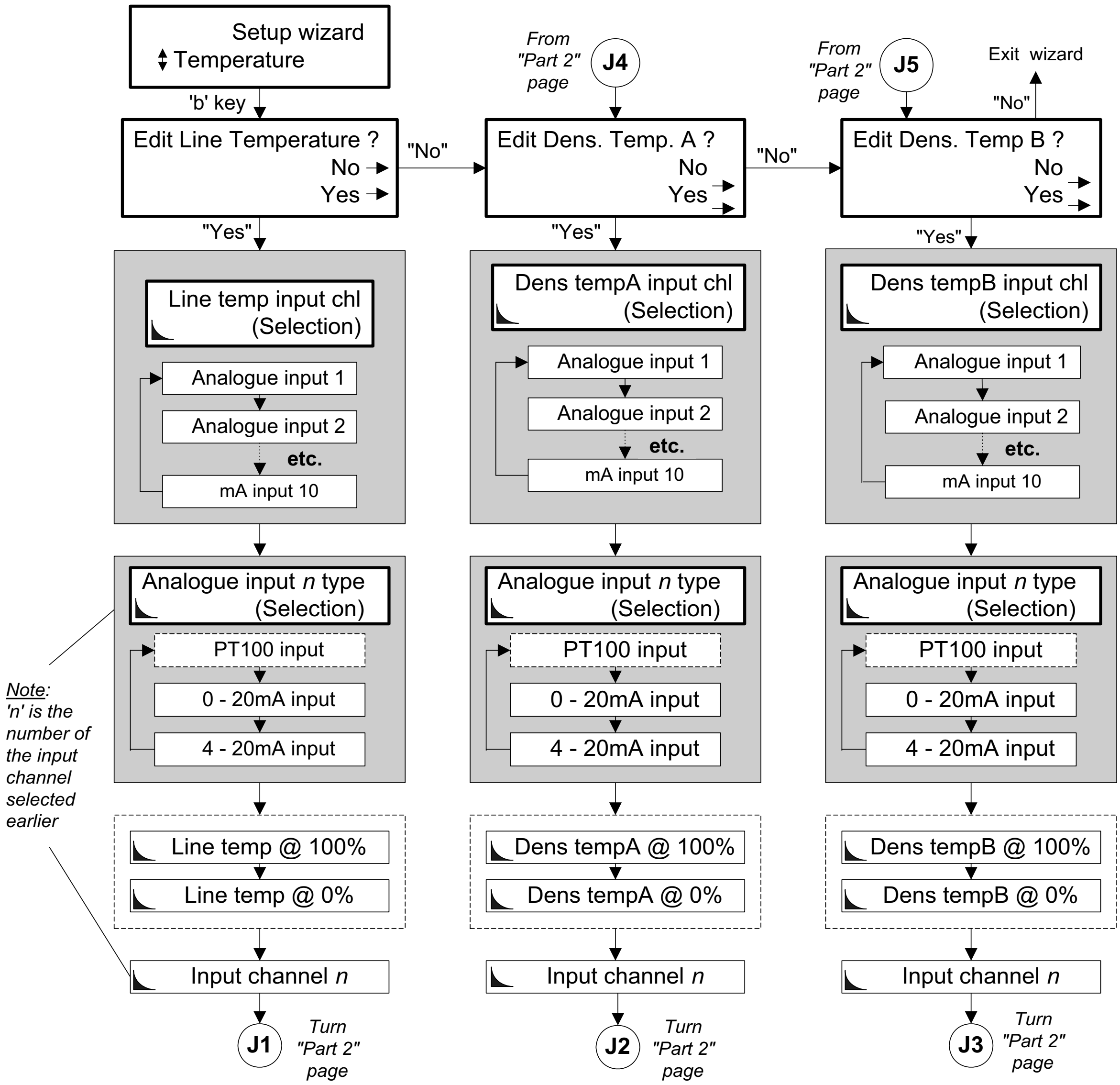
Sequence : Specific gravity ‘B’ measurement from an analogue input



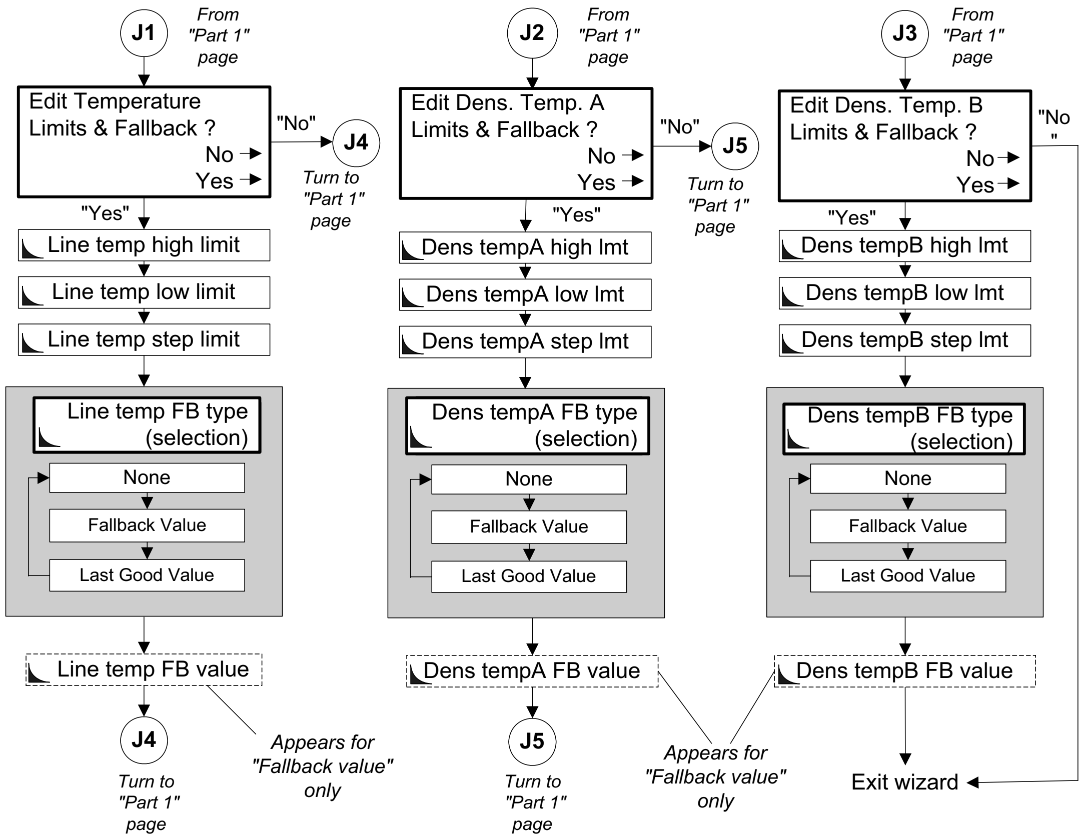
“Base density” Wizard Map - Part 2 of 2

10.15 Temperature wizard

This wizard configures the 795x for getting line temperature 'A' and/or density temperature 'A' and/or density temperature 'B' data.



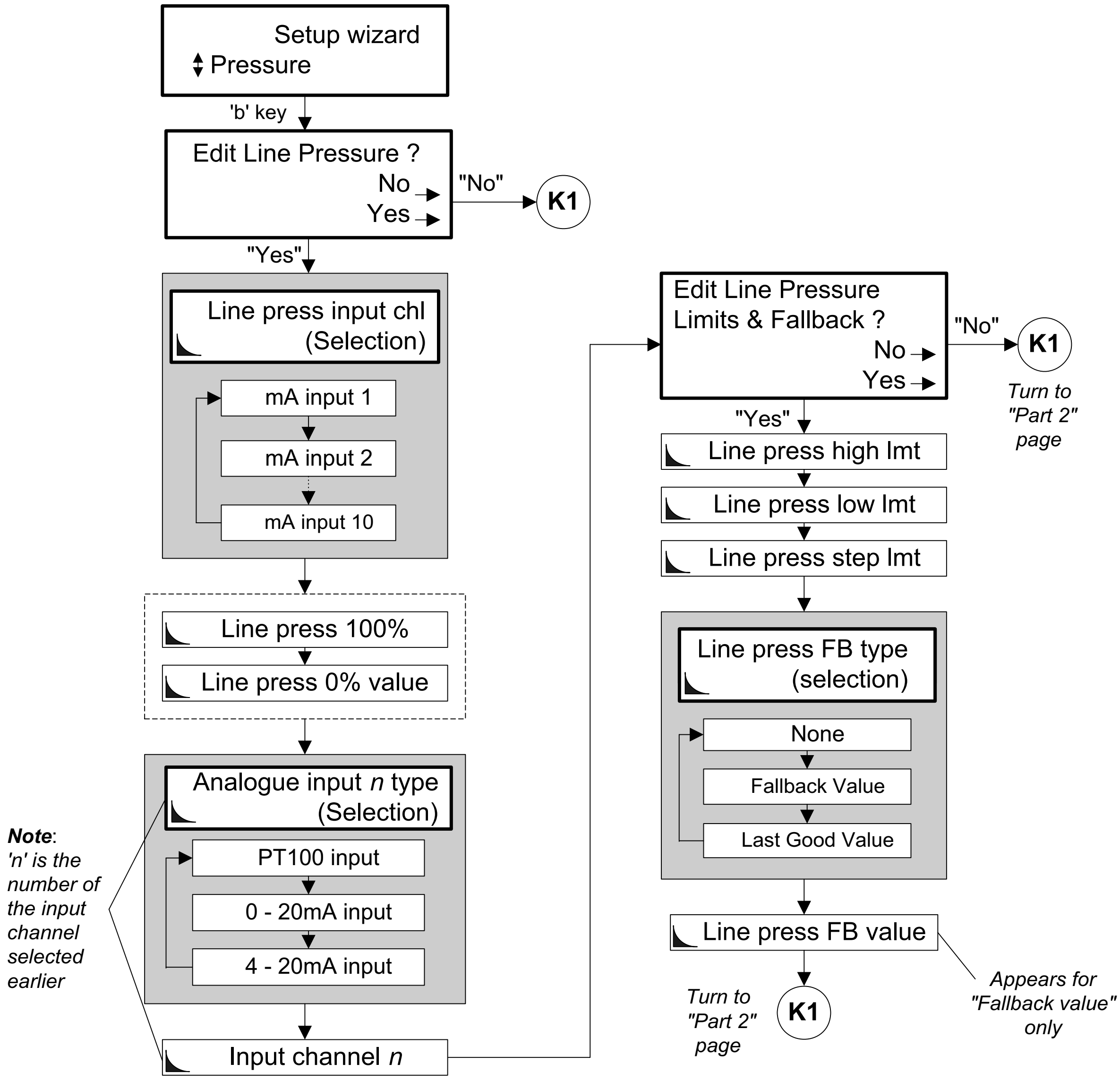
"Temperature" Wizard Map - Part 1 of 2



"Temperature" Wizard Map - Part 2 of 2

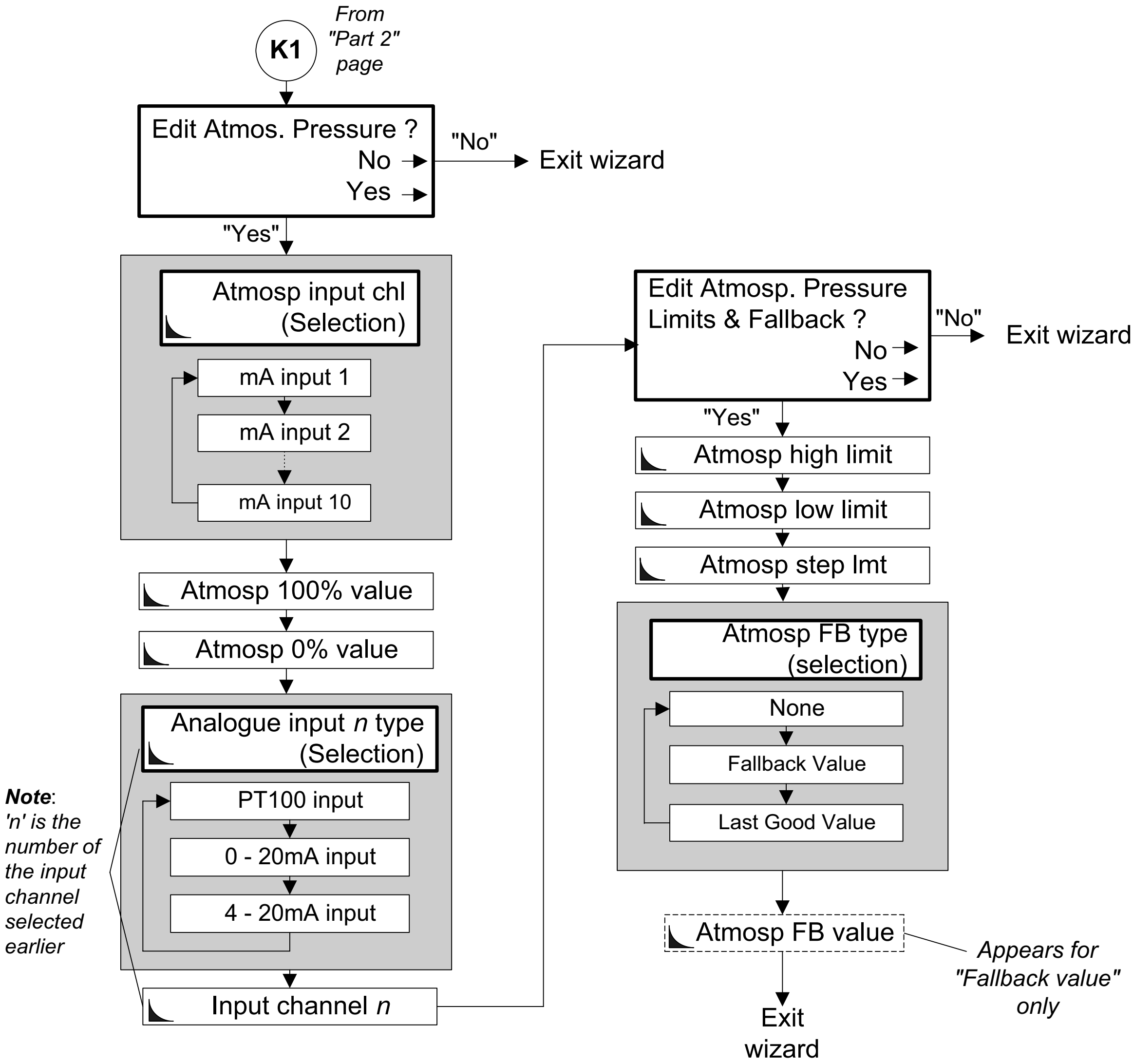
10.16 Pressure wizard

This wizard configures the 795x for getting line pressure and/or atmospheric pressure data.



“Pressure” Wizard Map - Part 1 of 2

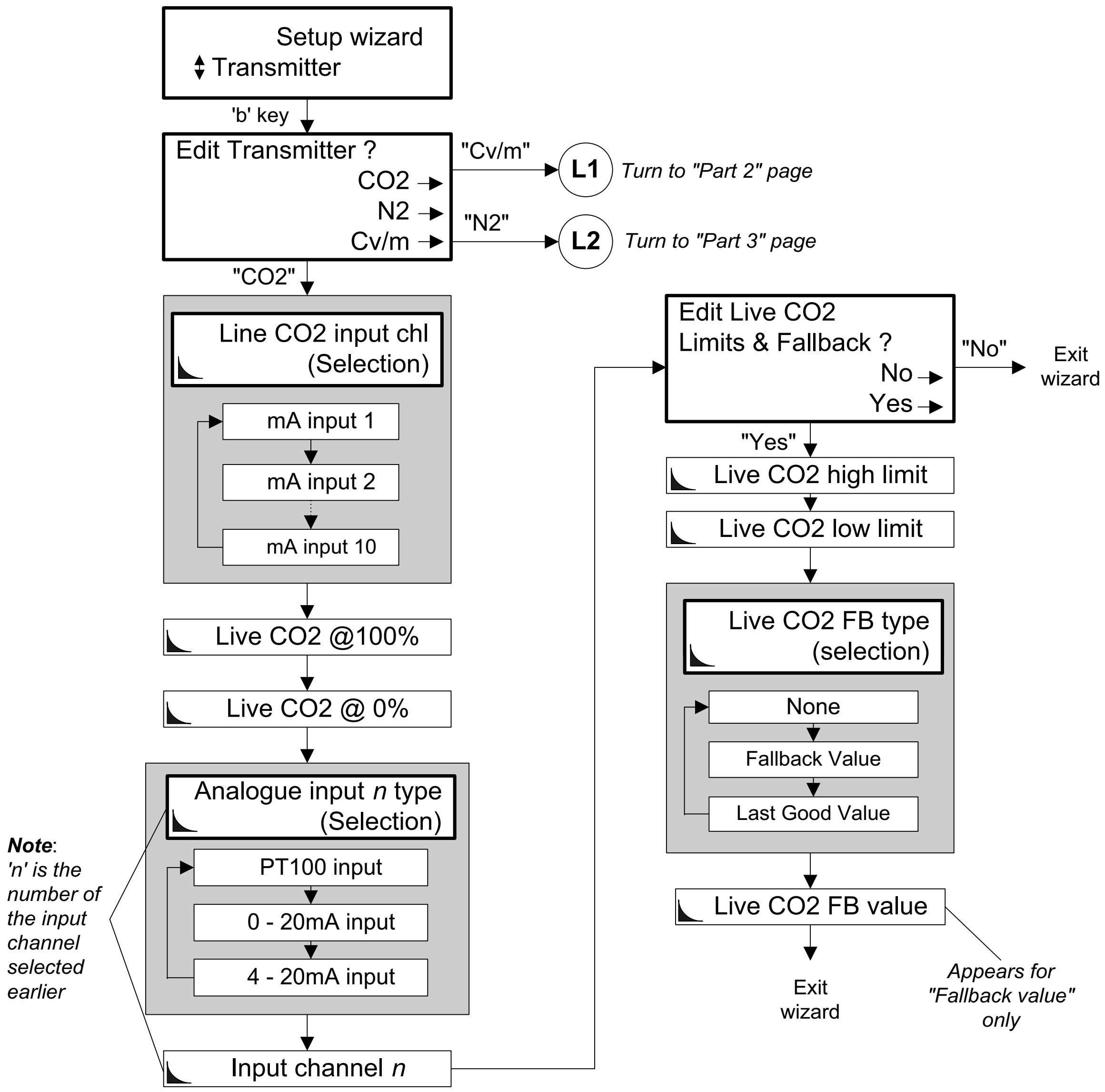
Sequence : Atmospheric pressure from an analogue input



"Pressure" Wizard Map - Part 2 of 2

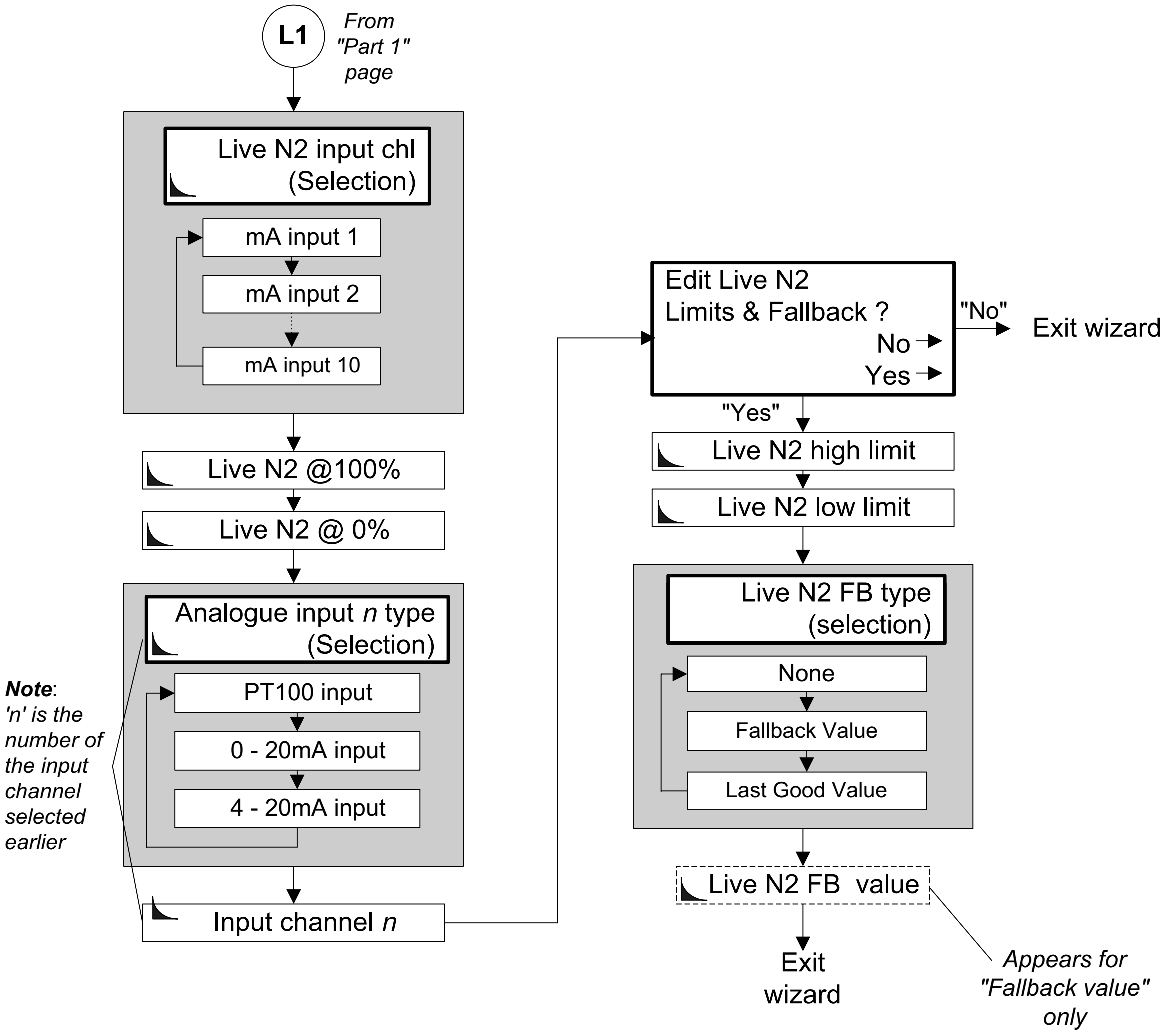
10.17 Transmitter wizard

This wizard configures the 795x for getting live CO_2 and/or live N_2 and/or live energy data.



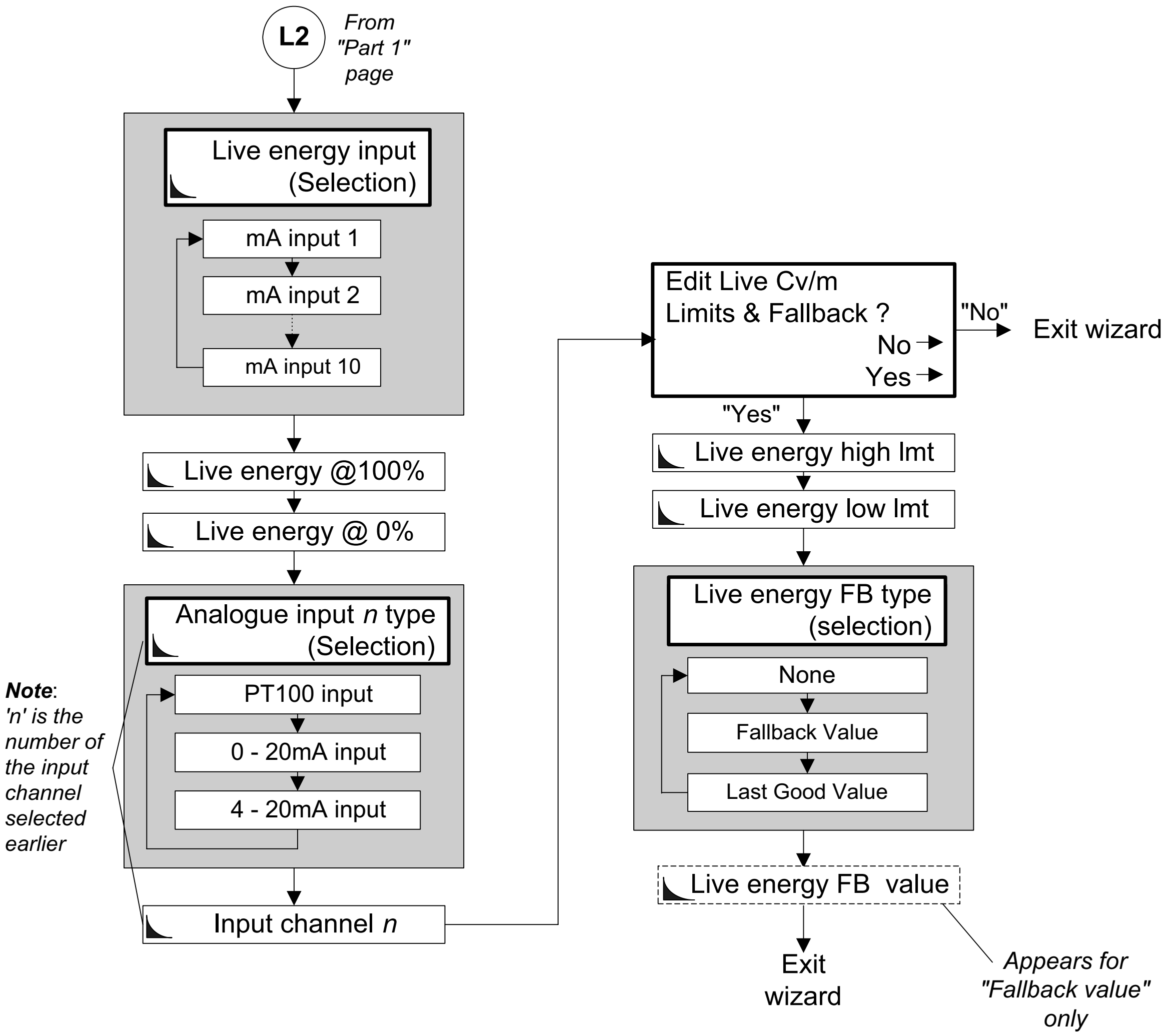
"Transmitter" Wizard Map - Part 1 of 3

Sequence : Live N2 from an analogue input



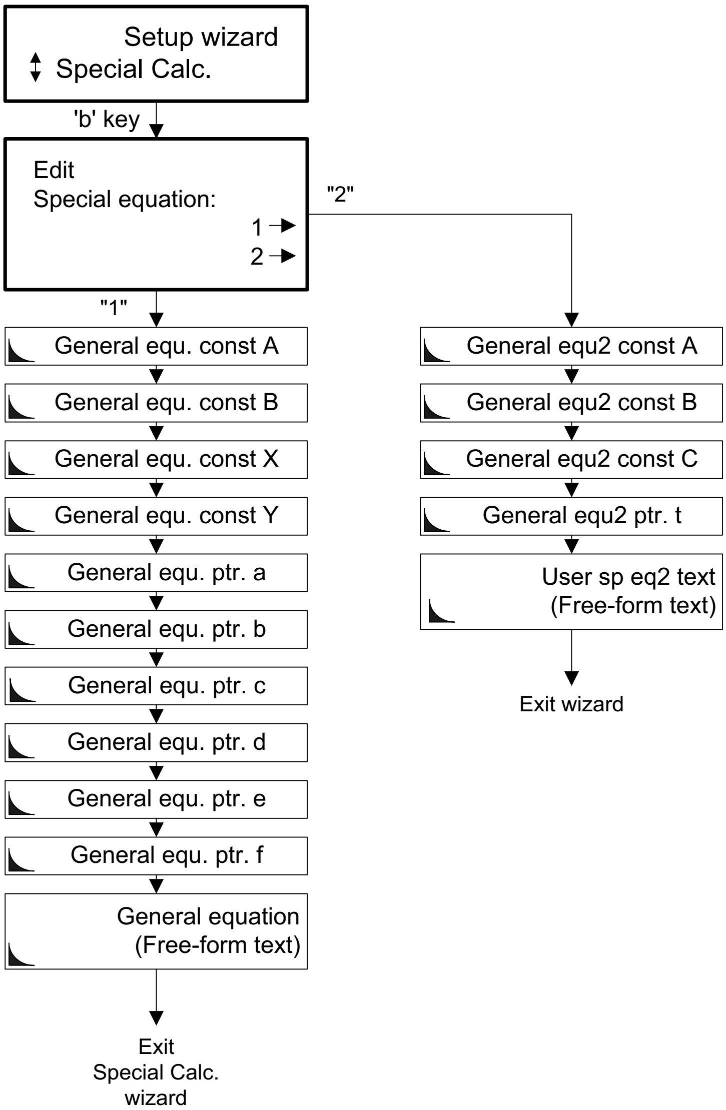
"Transmitter" Wizard Map - Part 2 of 3

Sequence : Live energy value from an analogue input



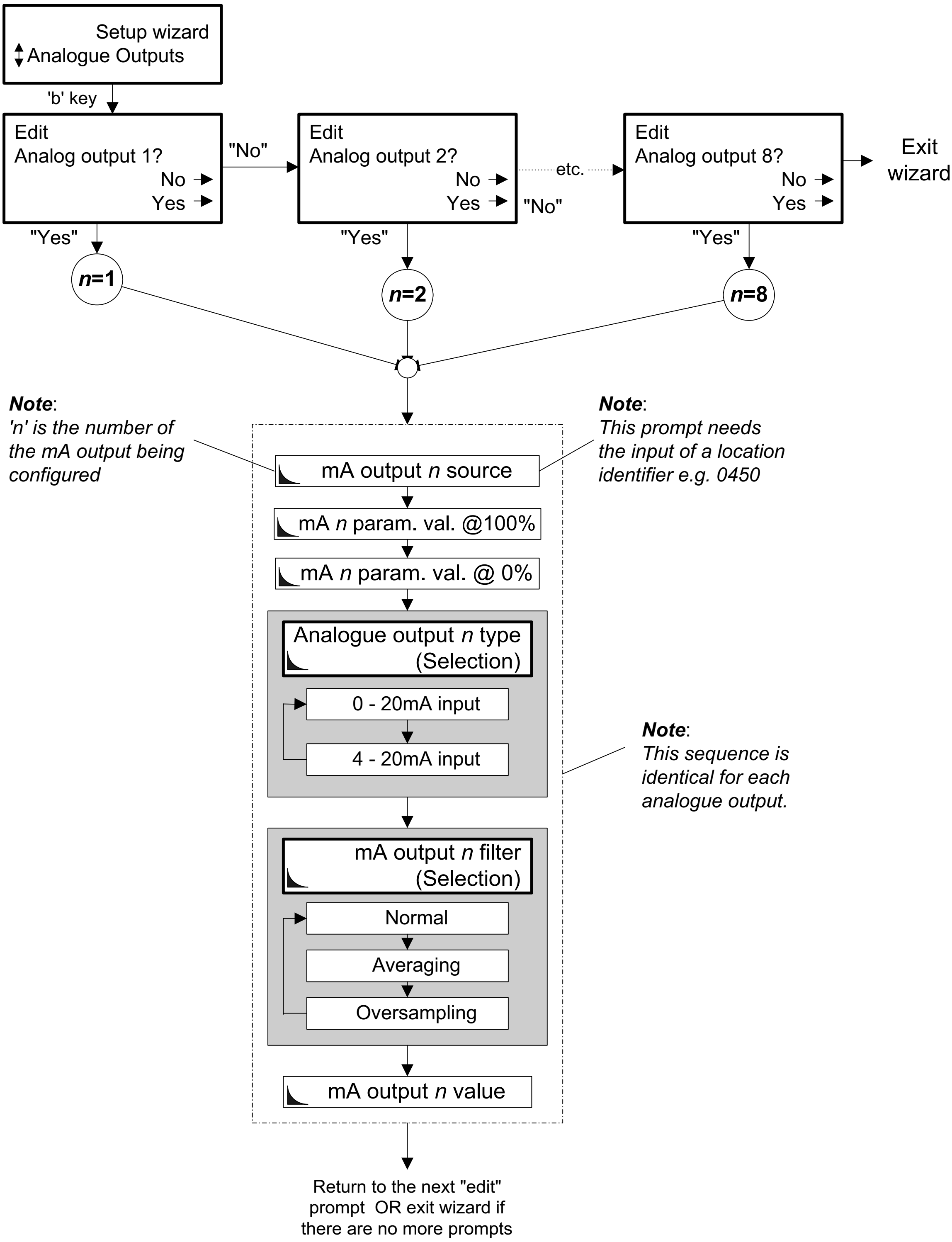
"Transmitter" Wizard Map - Part 3 of 3

10.18 Special Calculation wizard



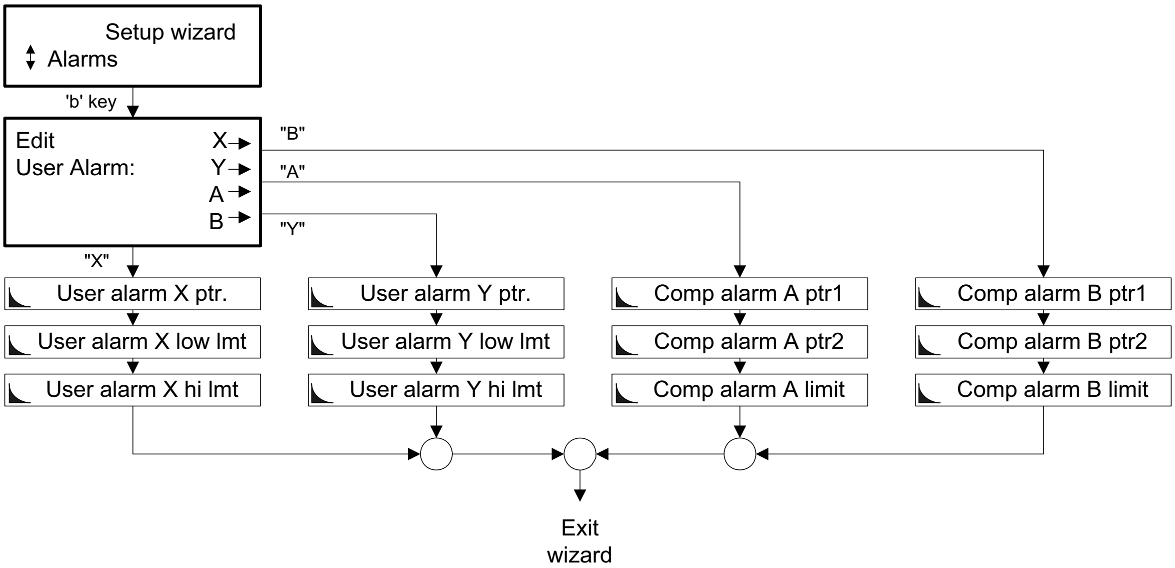
"Multi-view" Wizard Map

10.19 Analogue outputs wizard



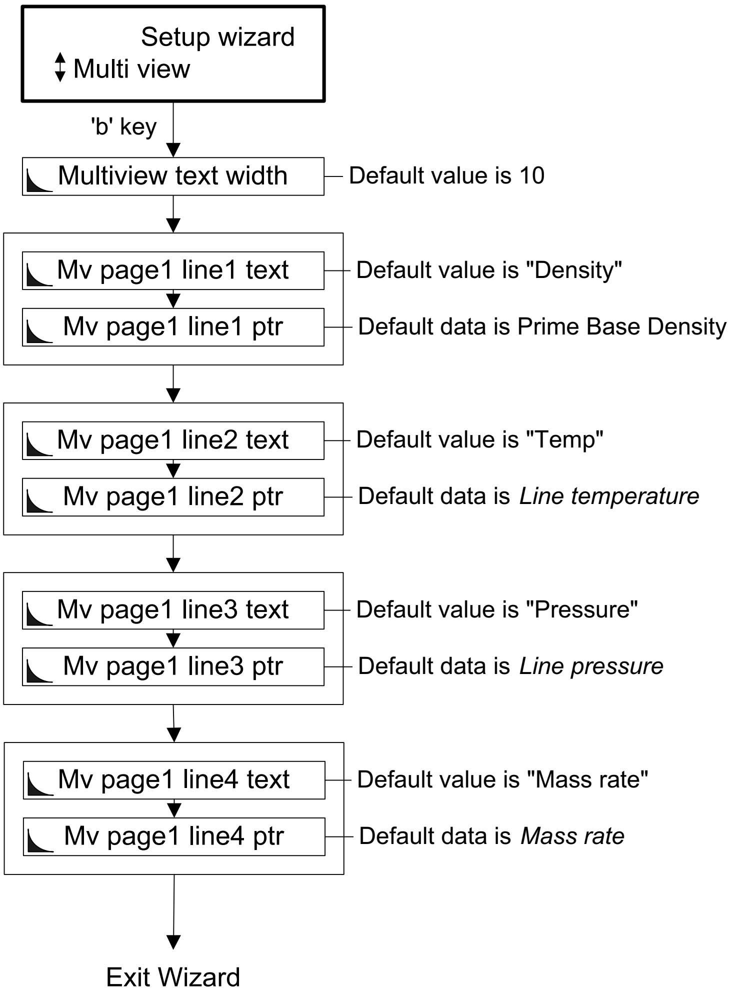
"Analogue outputs" Wizard Map

10.20 Alarms wizard



"Alarms" Wizard Map

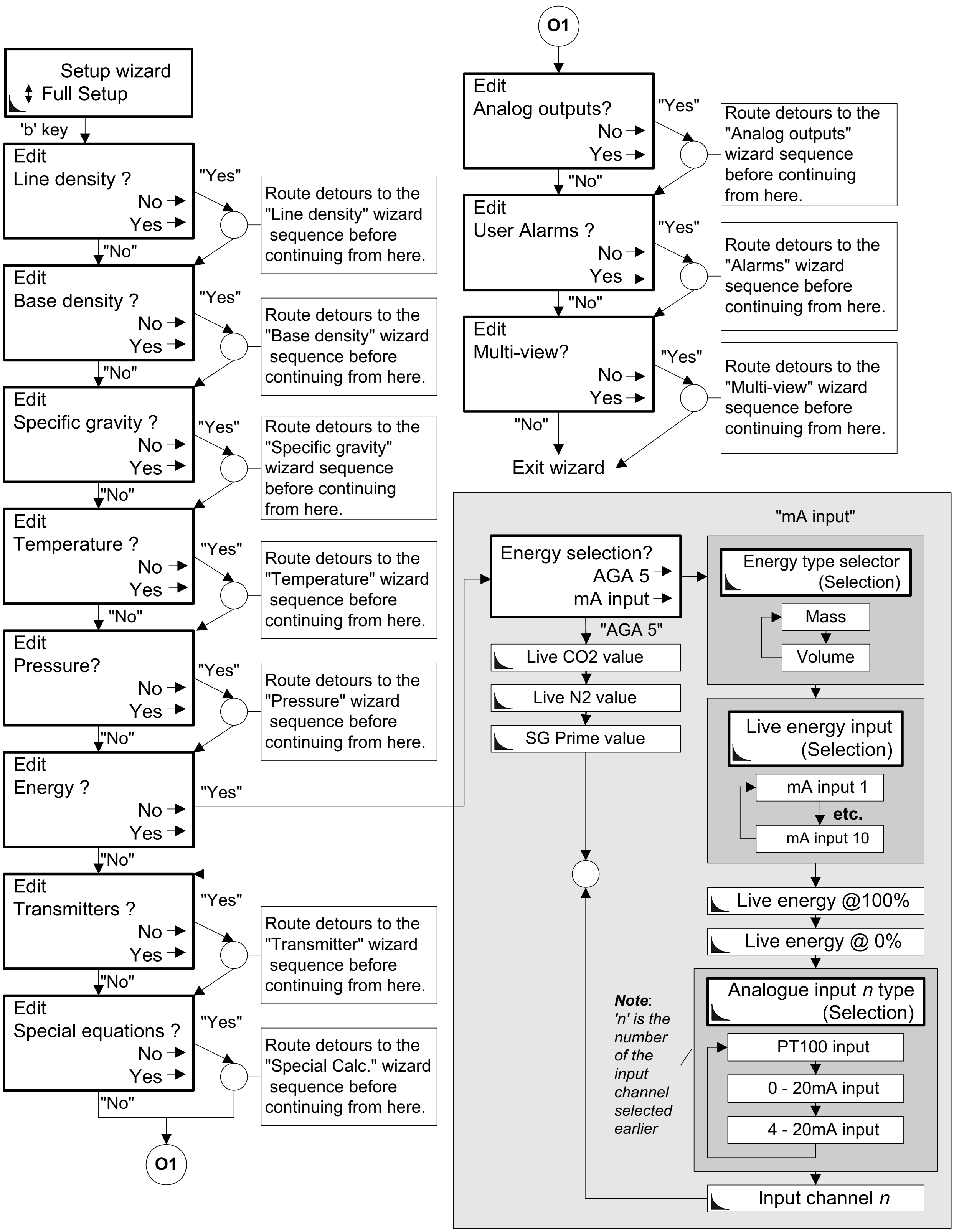
10.21 Multi-view wizard



"Multi-view" Wizard Map

10.22 Full Setup

This wizard consists of multiple wizards.



11. Configuring by using the menus

The recommended way of configuring the 795x is by using wizards, as explained in Chapter 10. But you should use the methods given here if:

- You want to configure an installation which is very different from the examples shown in Chapter 10.
- You want to change only a part of an existing configuration, irrespective of how it was configured in the first place.
- You are experienced in using the 795x menus.

11.1 What does configuration involve?

After you have installed the instrument and made sure that it is working, you must tell it:

- What inputs the field transmitters are connected to.
- How input data is to be processed.
- How results are to be output.

There is a default configuration which covers a general application. However, it is usually necessary to edit this configuration to suit particular needs.

11.2 Before you start

Before you begin configuring you must obtain the calibration certificates for all the field transmitters connected to the 795x. The diagram on Page 11.4 shows an example of a typical calibration certificate.

If you have followed the installation procedure given in Chapter 5, the instrument is ready to be configured. Otherwise, you must make sure before continuing that:

- The dip switches for the analogue inputs are set as explained in Chapter 5.
- All instrumentation has been connected.
- The instrument is powered up.

11.3 Recommended sequence for configuration

It is recommended that you configure items in the following order:

1. Inputs (See Section 11.5).
2. Transducer details (See Section 11.6).
3. Anything else such as Specific Gravity, Energy, Custom Application, Multiview, etc. Do these in the order in which they appear in this chapter. (See Sections 11.7- 11.18).

Item to be configured	Calculations involved (if any)	See Section
Analogue inputs	-	11.5
Transducer details	-	11.6
Transmitter details	Line temperature Densitometer temperature Atmospheric pressure Live CO2 and N2	11.7
Flowmeter details	Orifice mass and volume flow rate Turbine mass and volume flow rate Prime specific gravity	11.8
Flow rate	Turbine mass and volume flow rate Standard volume rate	11.9
Totalisers	Totalisation	11.10
Line density	Line density AGA8 density compressibility Normalisation of gas components Nx-19 compressibility Linear interpolation compressibility SGERG compressibility Density referral	11.11
Base density	Base density Prime base density	11.12
Specific gravity	Specific gravity Prime specific gravity	11.13
Energy	Energy Energy rate	11.14
Custom application	User calculations 1 and 2	11.15
mA outputs	mA outputs	11.16
Other parameters	-	11.17
Multiview	-	11.18

11.4 What Sections 11.5- 11.18 tell you

Each section tells you how to configure one parameter. The format of each section is:

- (Where necessary) a statement which tells you what information you must have to configure the parameter.
- (Where necessary) a block diagram showing how the instrument uses information from the transducers (“Live Data”) and information you give it (“Fixed Data”) to calculate the value of the parameter.
- A diagram which shows that part of the menu system which you use to configure the parameter.

Sections 11.17 (Configuring other parameters) and 11.18 (Configuring Multiview) have a slightly different format from the others because of the special nature of the topics they deal with.

The table on page 11.2 lists the items which you can configure and, for each, the calculations (if any) which are involved in obtaining the value of the item.

In the menu diagrams, where an item is shown in brackets, the actual value or setting appears in the menu at that point. For example:

(Value)	The display shows the actual value of the parameter.
(Units)	The display shows the actual units.
(Live or set)	The display shows whether the parameter is LIVE or SET.

```
                 C A L I B R A T I O N    C E R T I F I C A T E

78123A GAS DENSITY METER                               SERIAL NO :  nnnnnn
                                                     CYLINDER NO :
                                                    AMPLIFIER NO :
                                                CALIBRATION DATE :

PRESSURE TESTED TO 375 BAR

DENSITY CALIBRATION FOR NITROGEN AT 20 DEG C
      (Based on Pressure-Temperature-Density Data in IUPAC tables)

     DENSITY     PERIODIC TIME
     [KG/M3]          [uS]

        n           nnn.nnn
       nn           nnn.nnn
       nn           nnn.nnn      DENSITY = K0  +  K1.T  +  K2.T**2
       nn           nnn.nnn
      nnn           nnn.nnn      K0  =   -n.nnnnnE+nn
      nnn           nnn.nnn      K1  =   -n.nnnnnE-nn
      nnn           nnn.nnn      K2  =    n.nnnnnE-nn
      nnn           nnn.nnn
      nnn           nnn.nnn
      nnn           nnn.nnn

TEMPERATURE COEFFICIENT DATA
      Dt = DI(1 + K18(t-20)) + K19(t-20)       K18 =   -n.nnnE-nn
                                               K19 =    n.nnnE-nn
USER GAS OFFSET DATA
      Argon/Methane gas mixture over density range 60 to 200 KG/M3

                (       K3     (            G  ))         K3 = nnn
        DA = Dt (1 + ------- (0.00236 - -----))          K4 = nnn.n
                (     (Dt+K4)  (           t+273))

        where
          T = Periodic time (uS)
         DA = Actual Density (KG/M3)           Gas Specific Gravity
          t = Temperature (DEG.C)          G = -----------------------
         DI = Indicated Density (KG/M3)        Ratio of Specific Heats
         Dt = Temp. Corrected Density (KG/M3)

    TESTER                                                   QC

  Ref No:- xxnnnn/Vn.n                               DATE : xxxxxxx
```


Figure 11.1 An example of a Calibration Certificate for a 7812 gas density transducer

11.5 Configuring analogue inputs

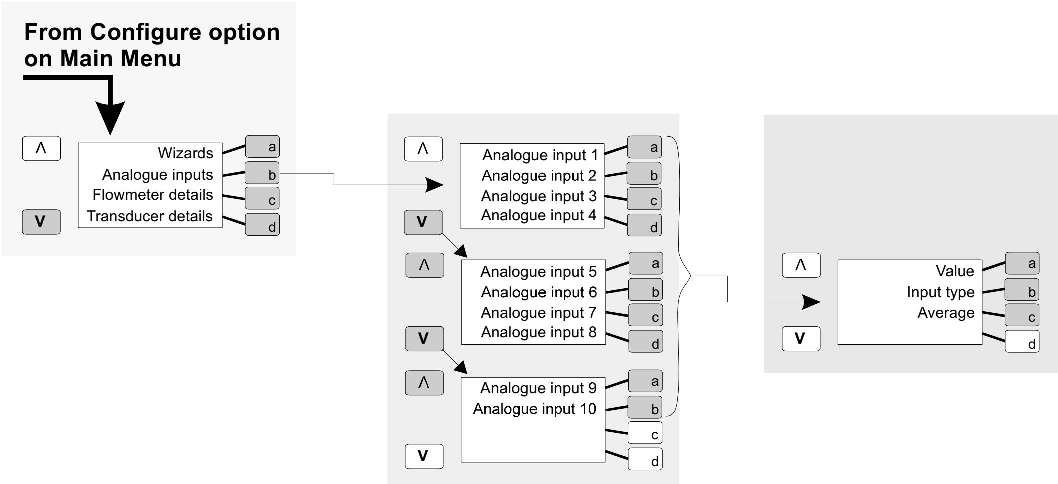


Figure 11.2 Menu structure for configuring analogue inputs

11.6 Configuring transducer details

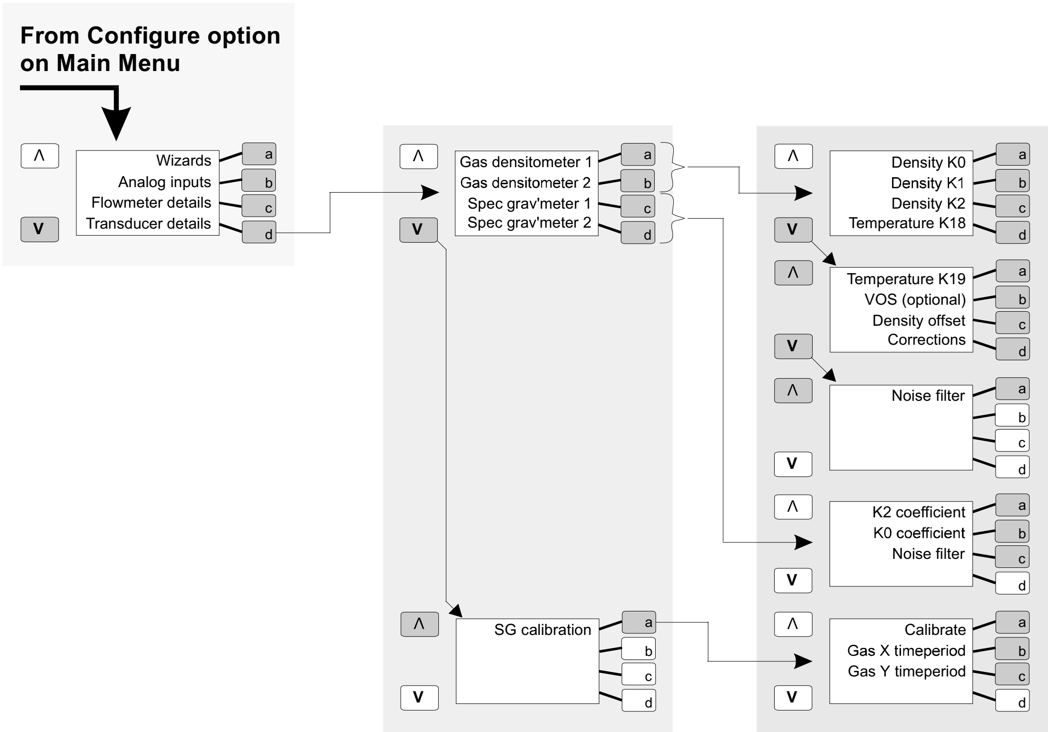


Figure 11.3 Menu structure for configuring transducer details

11.7 Configuring transmitter detail

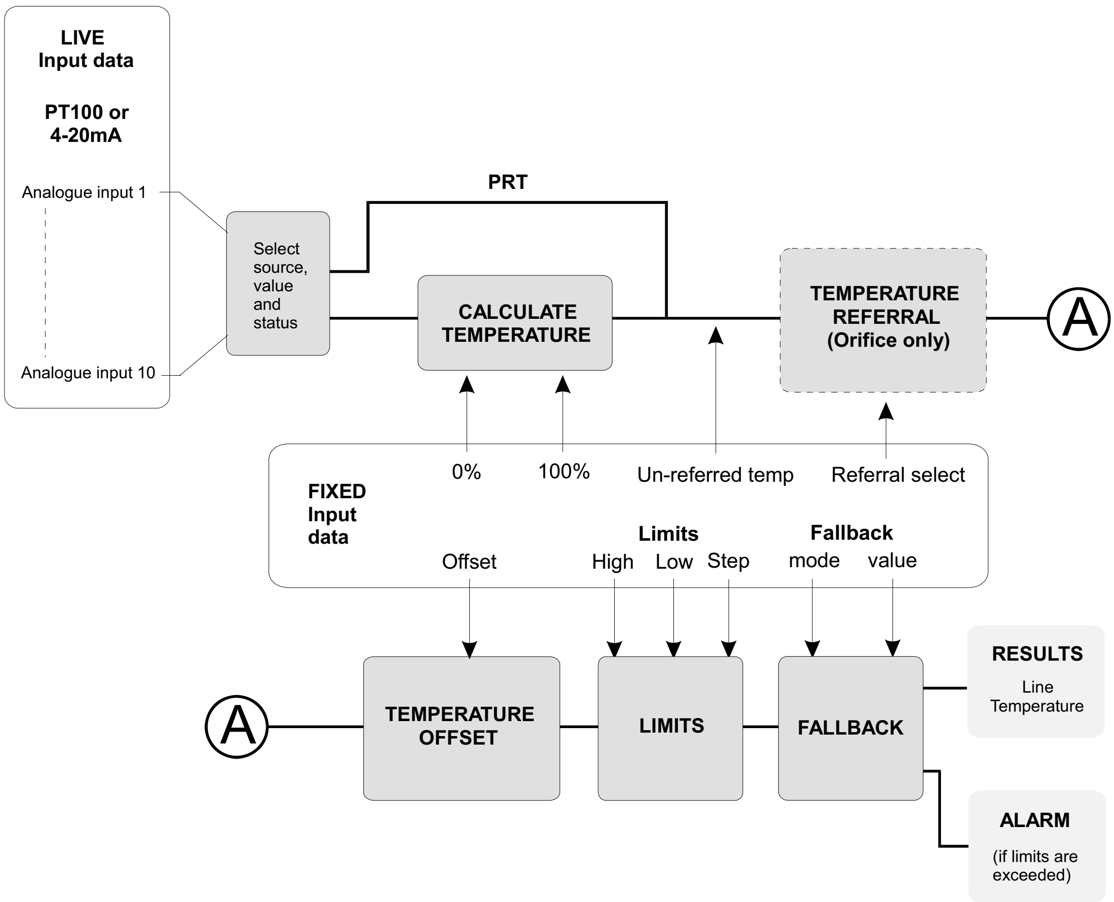


Figure 11.4 Calculating line temperature

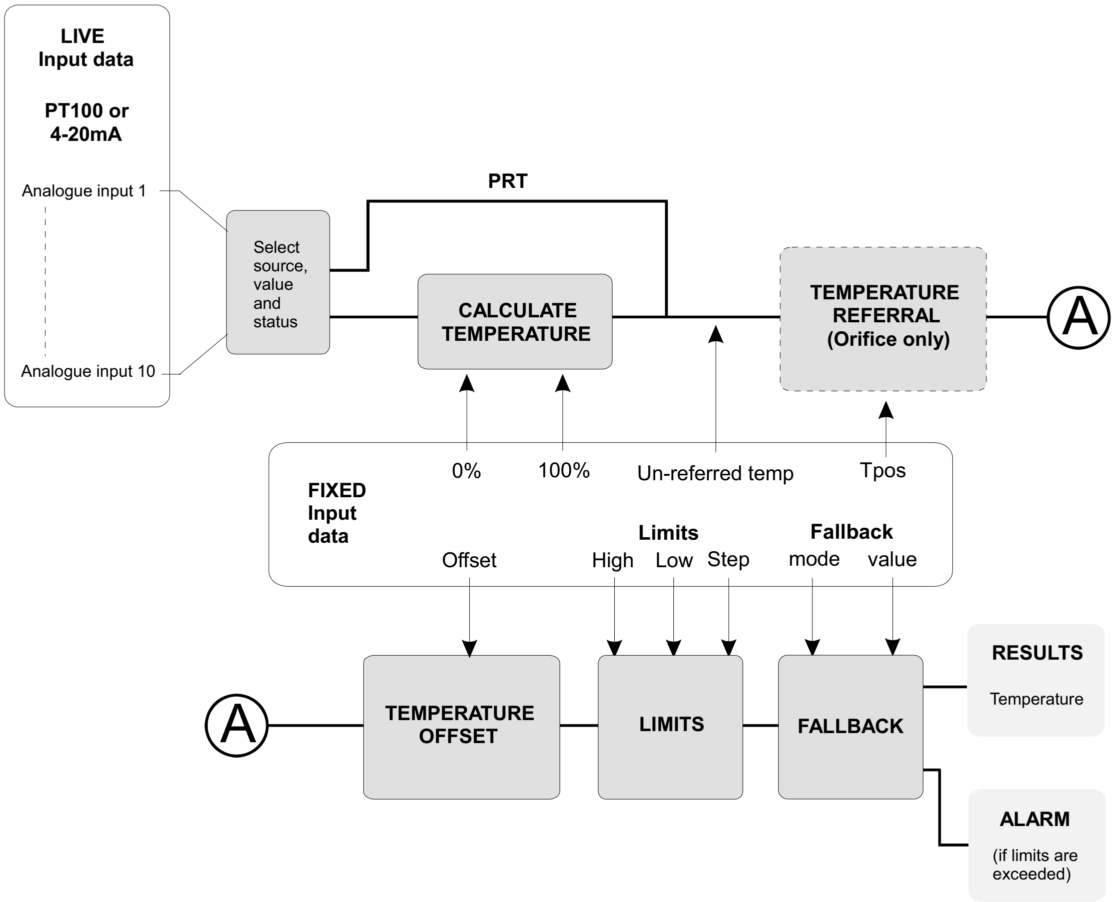


Figure 11.5 Calculating densitometer temperature

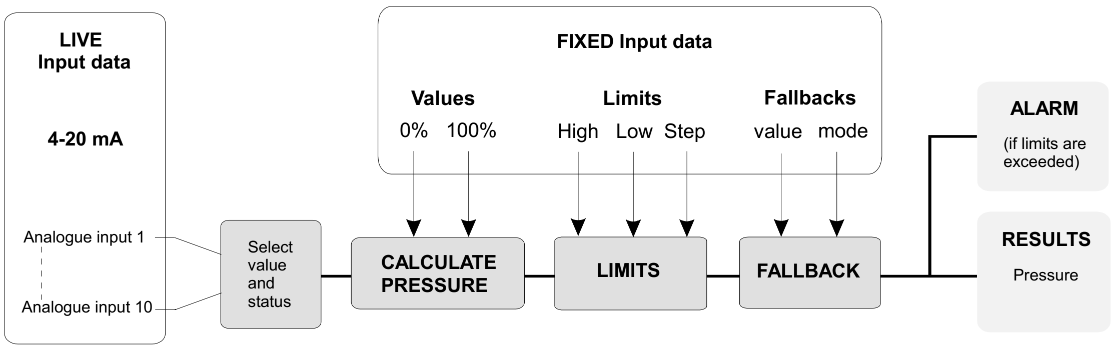


Figure 11.6 Calculating prover or atmospheric pressure

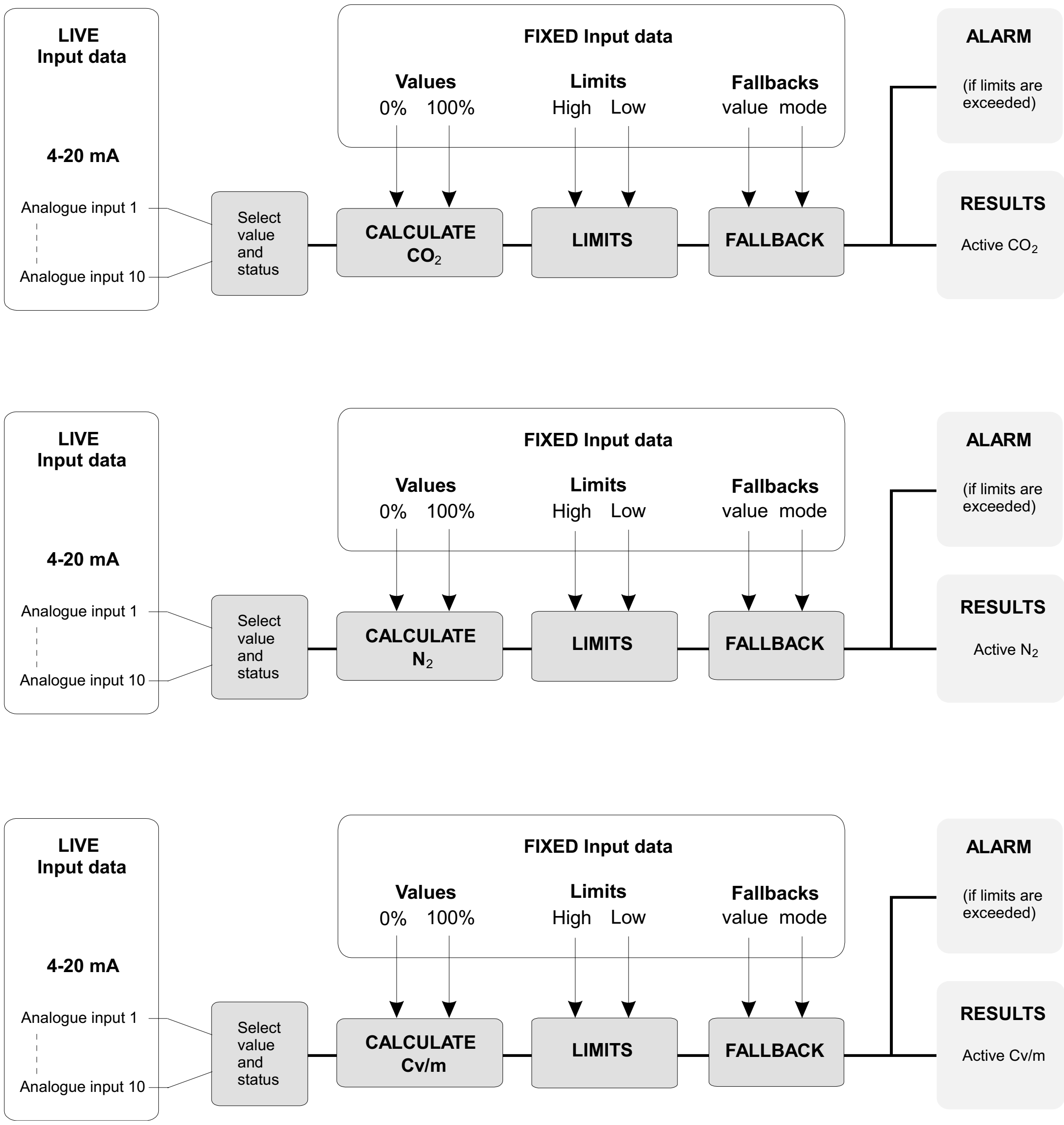


Figure 11.7 Calculating live CO2, N2 and Cv/m

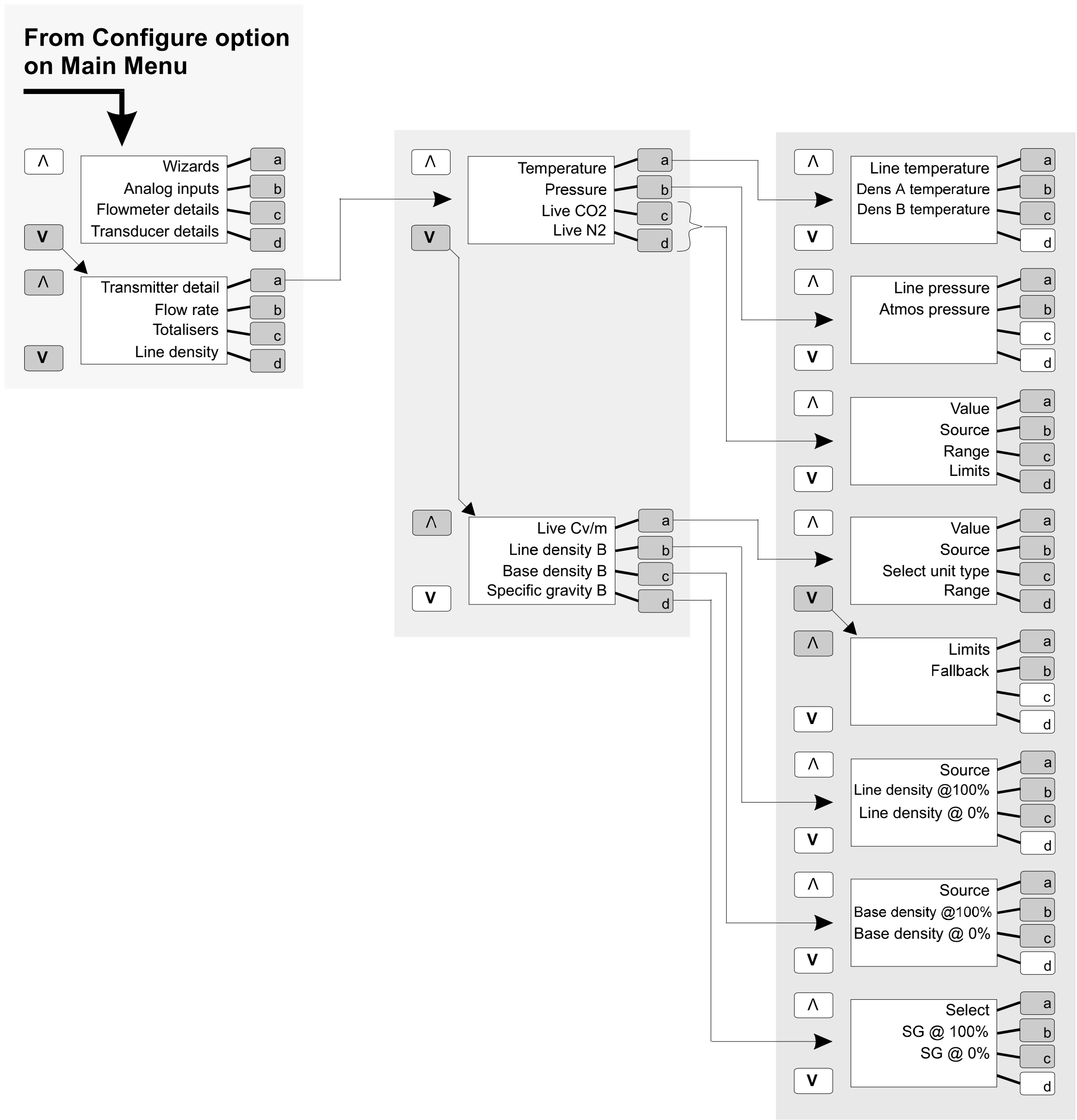


Figure 11.8 Menu structure for configuring transmitter detail

11.8 Configuring flowmeter details

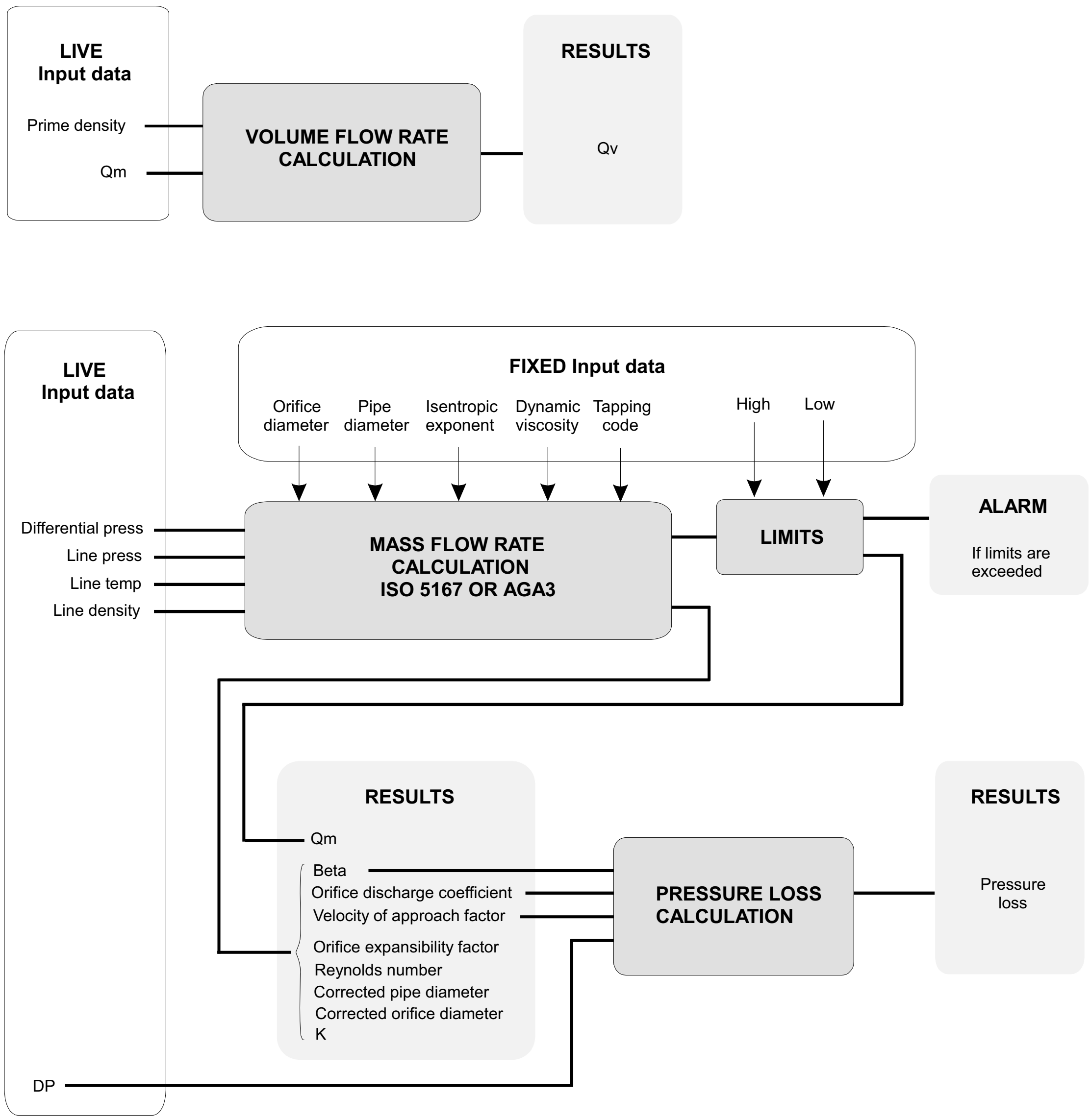


Figure 11.9 Calculating orifice mass and volume flow rate

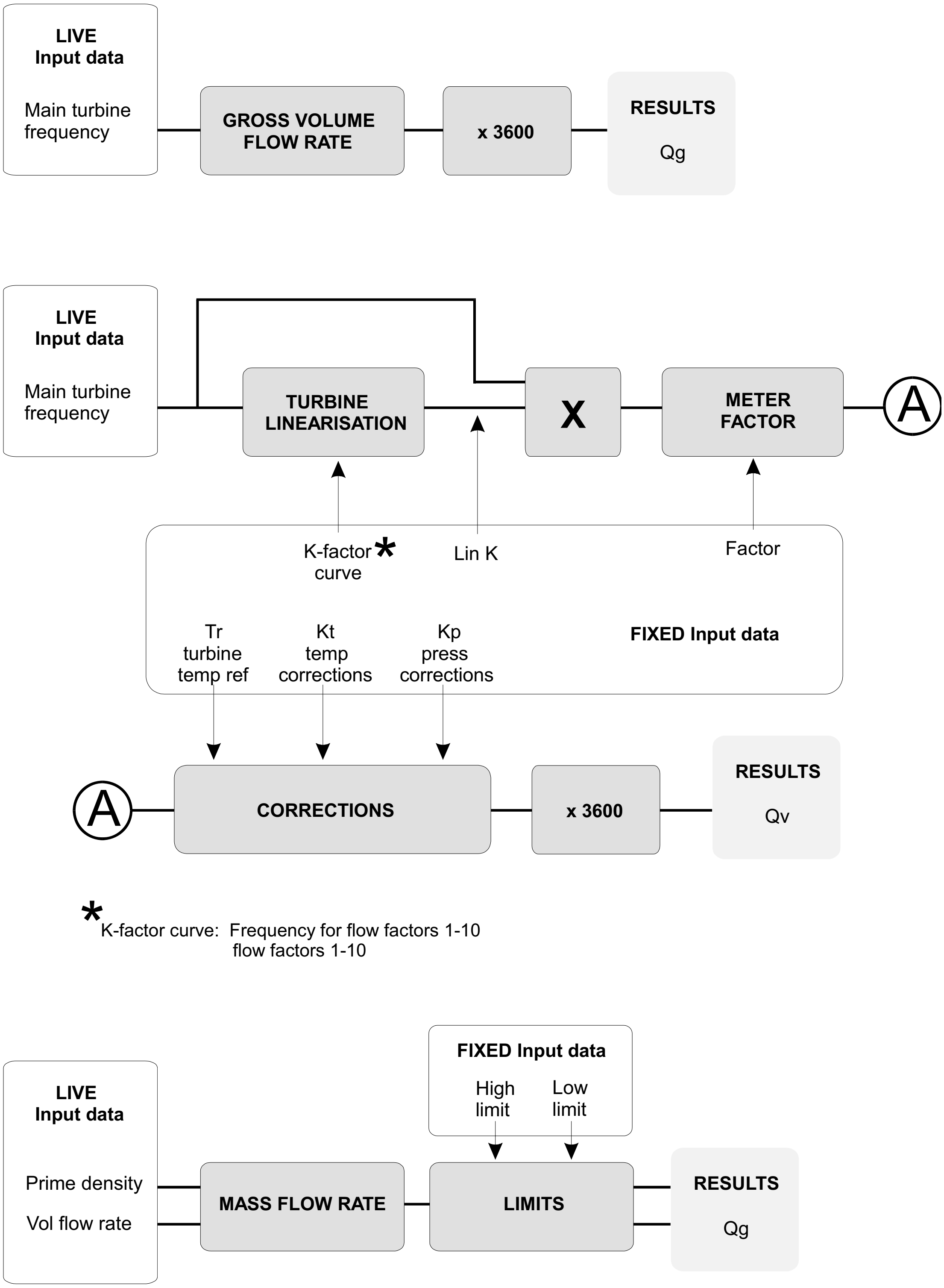


Figure 11.10 Calculating turbine mass and volume flow rate

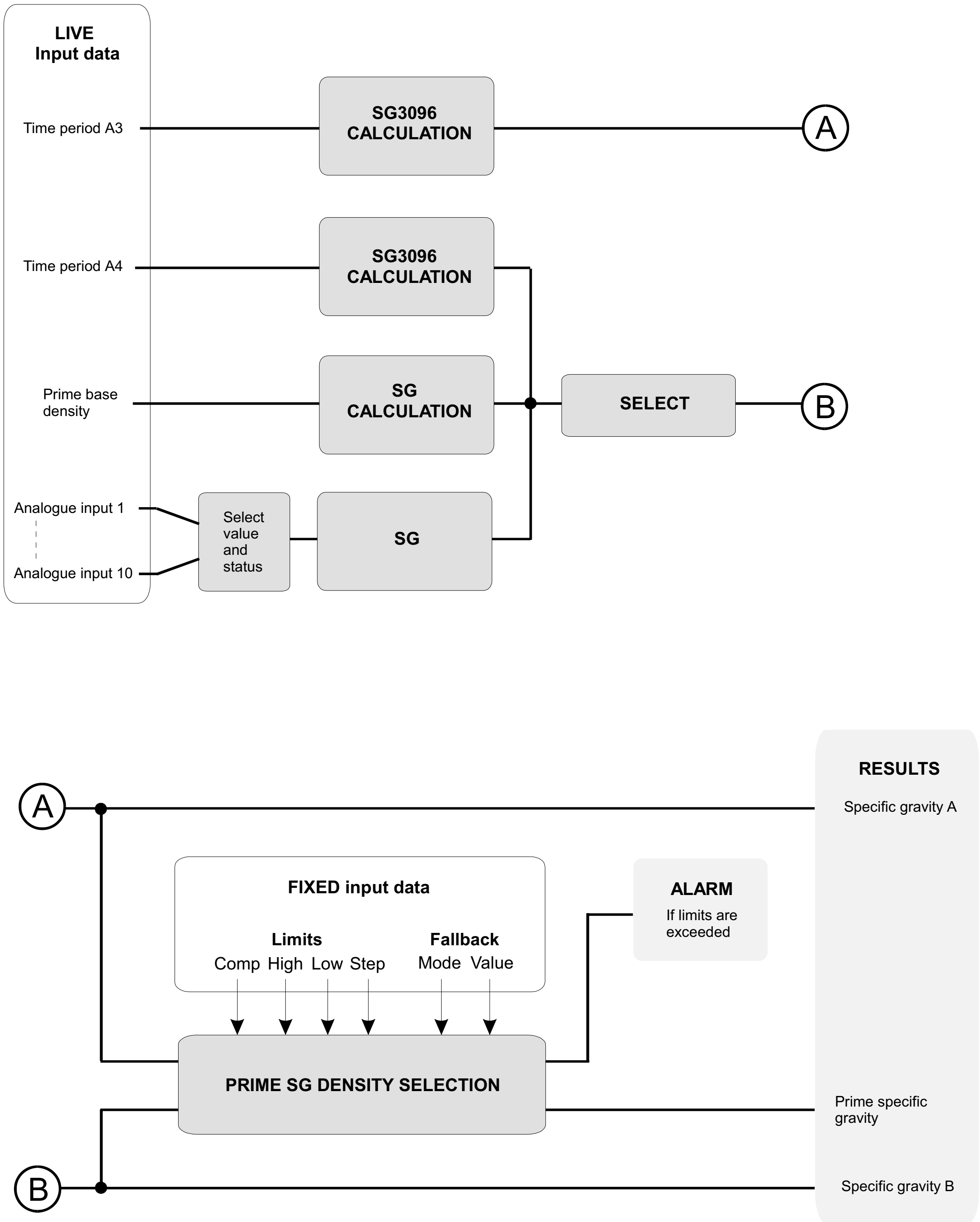


Figure 11.11 Calculating prime specific gravity

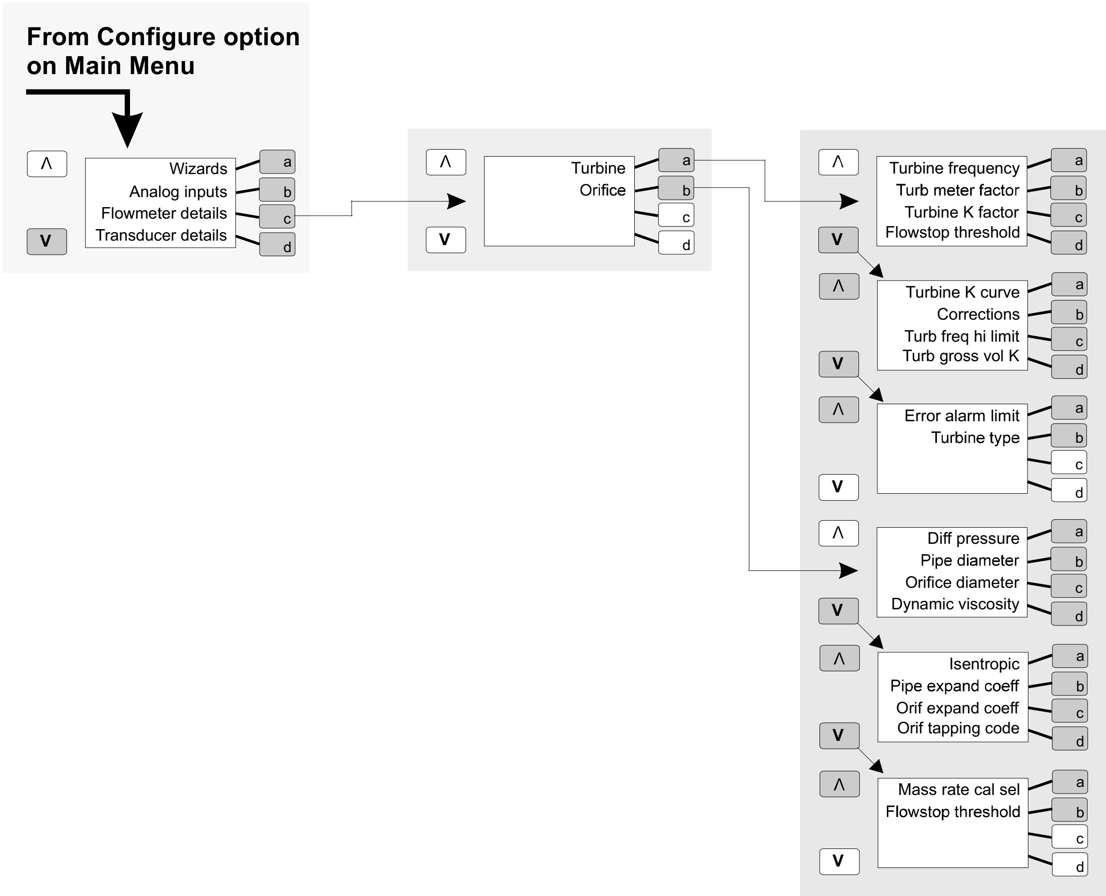


Figure 11.12 Menu structure for configuring flowmeter details

11.9 Configuring flow rate

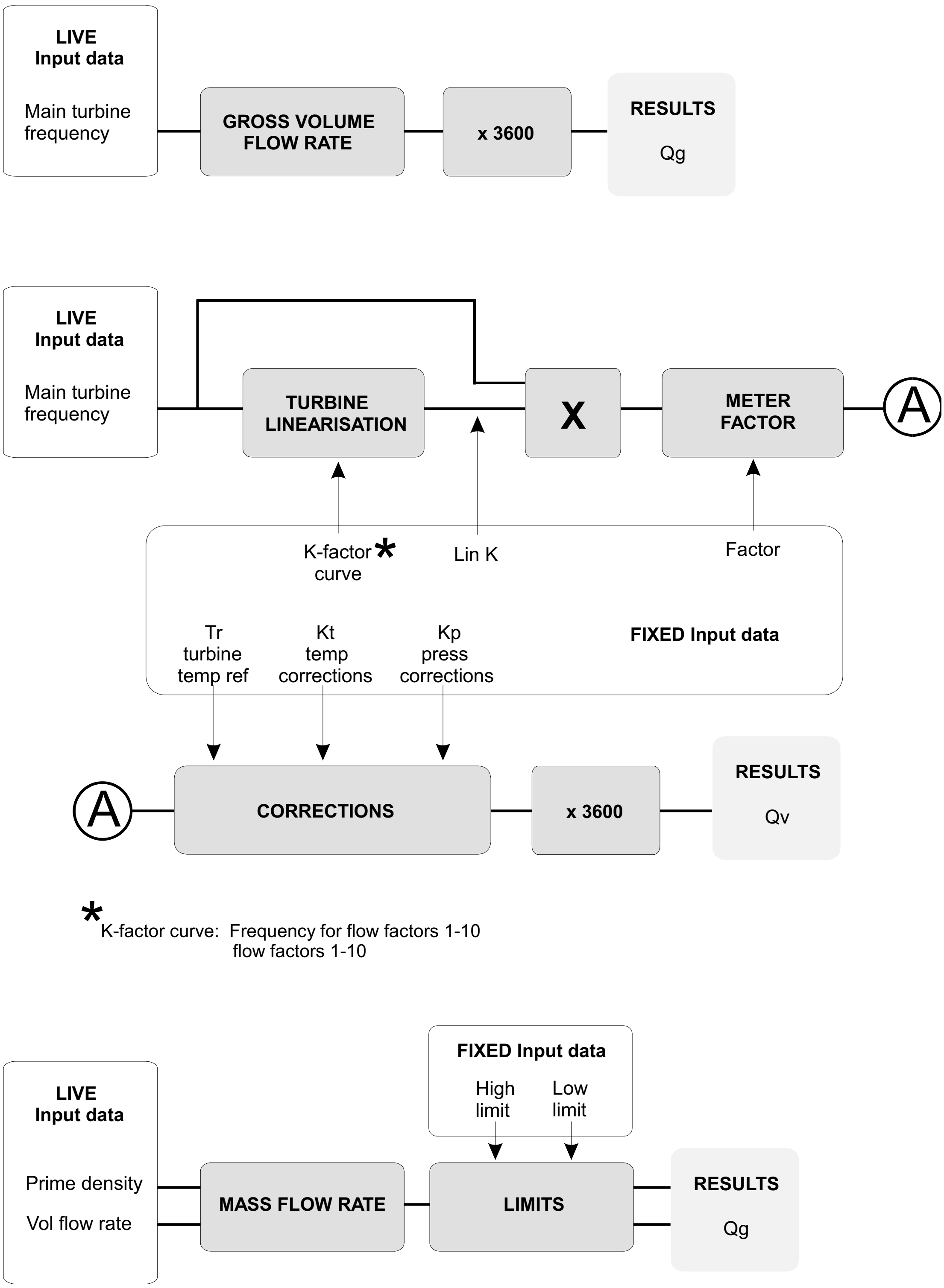


Figure 11.13 Calculating turbine mass and volume flow rate

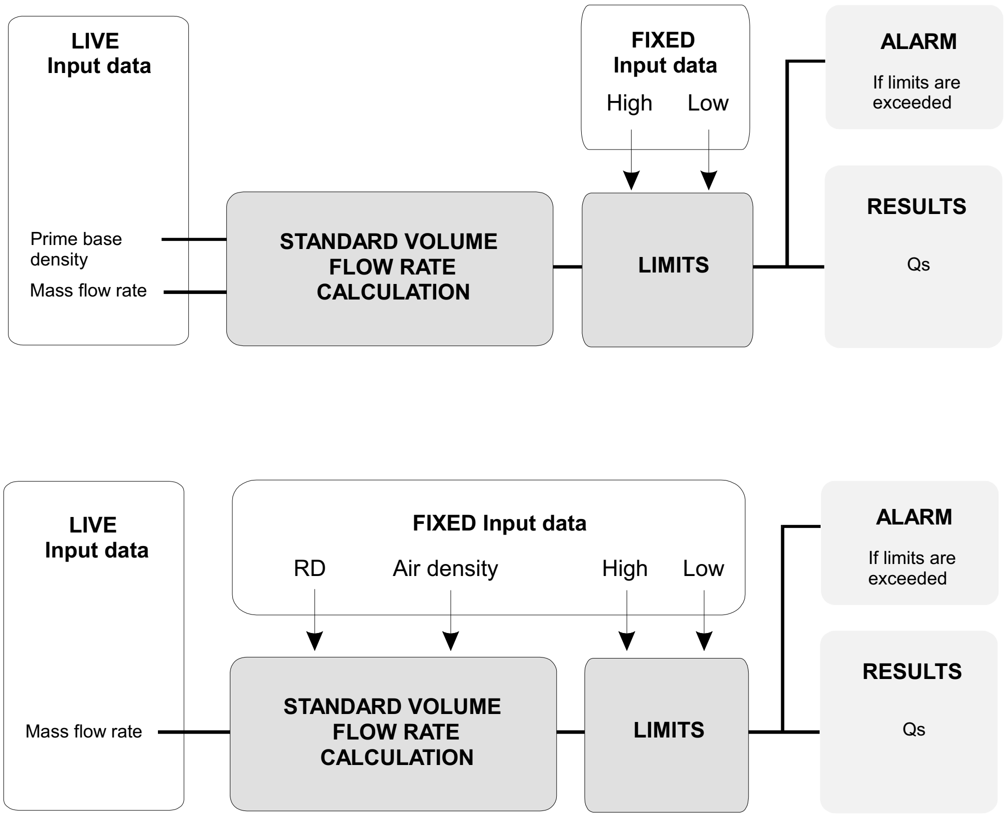


Figure 11.14 Calculating standard volume rate

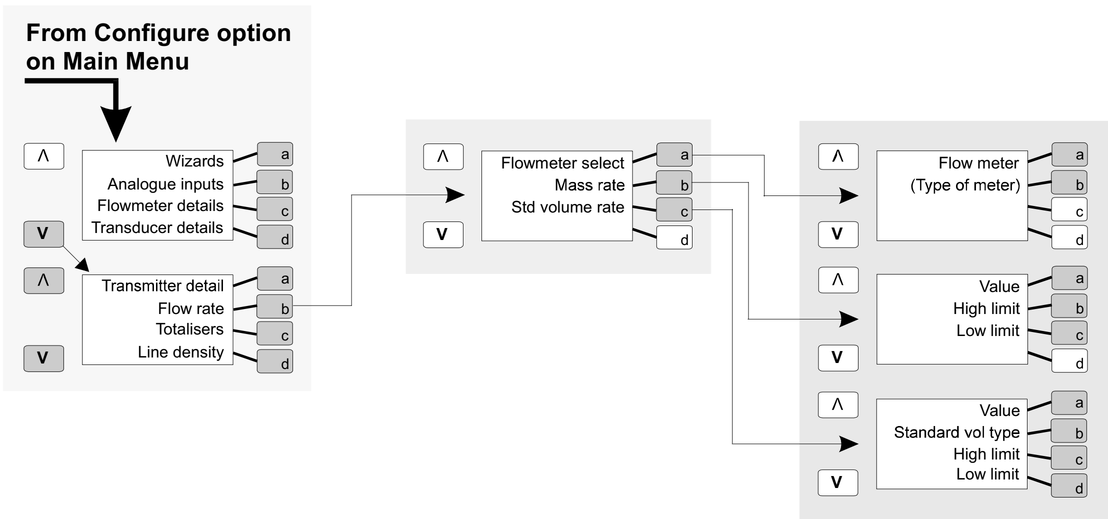


Figure 11.15 Menu structure for configuring flow rate

11.10 Configuring totalisers

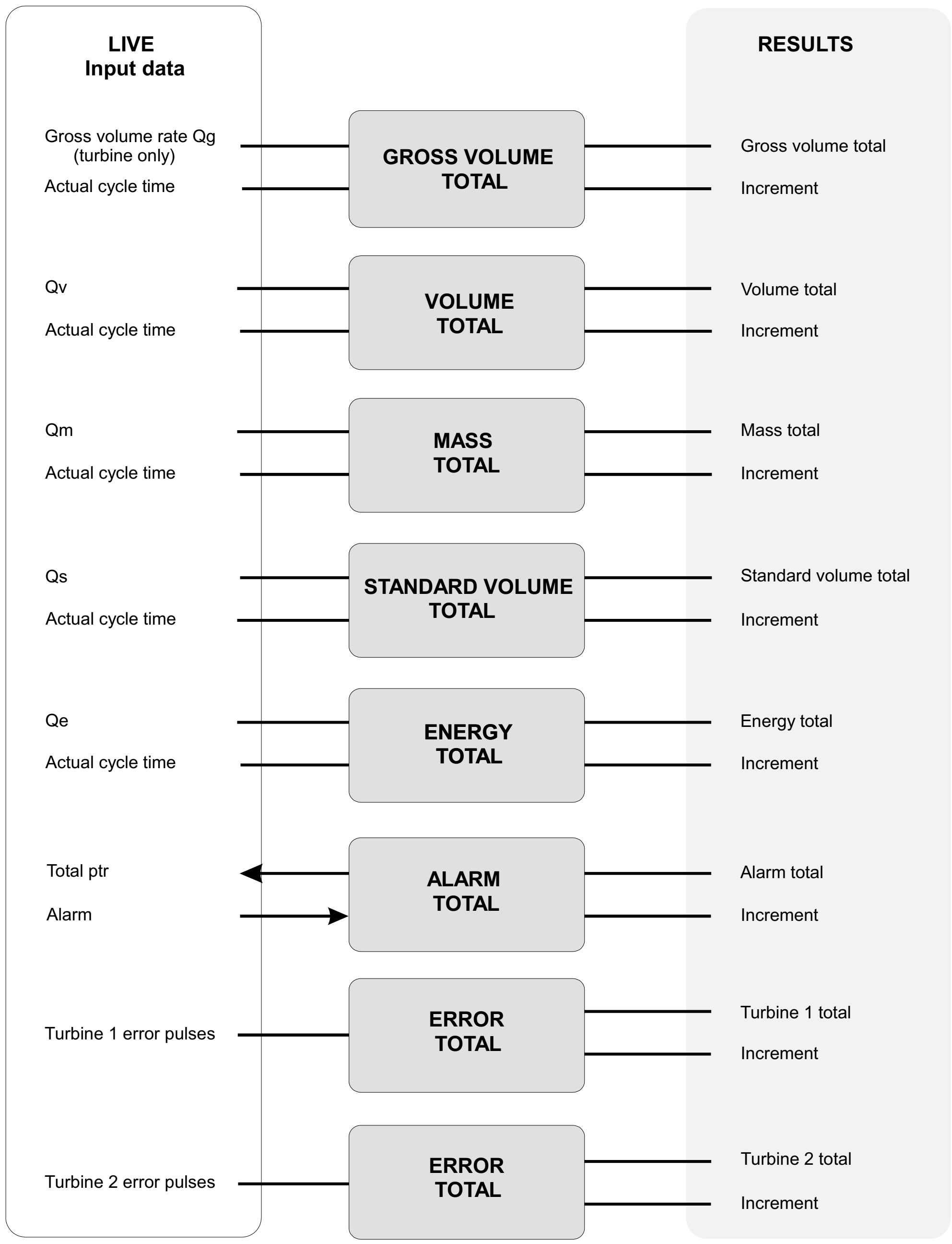


Figure 11.16 Totalisation calculations

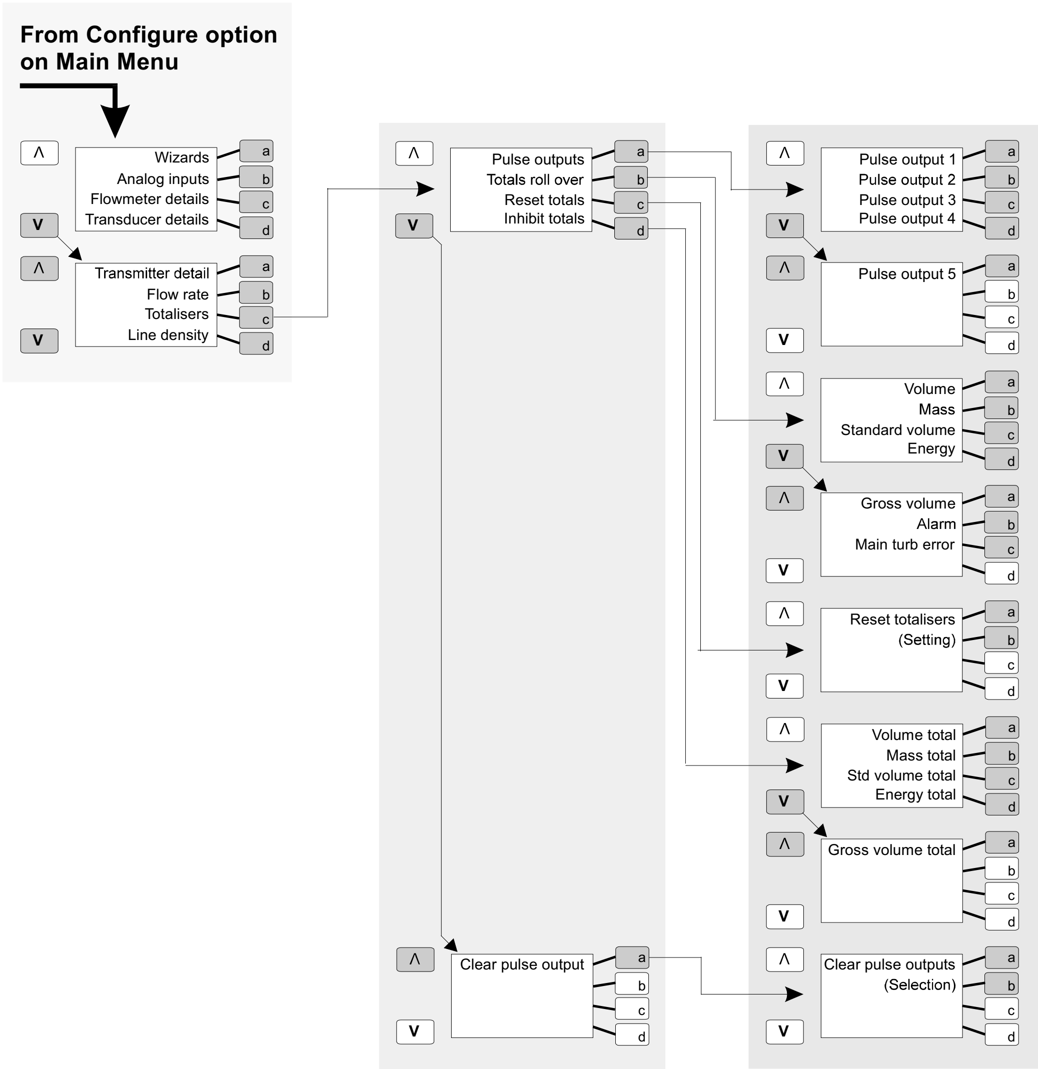


Figure 11.17 Menu structure for configuring totalisers

11.11 Configuring line density

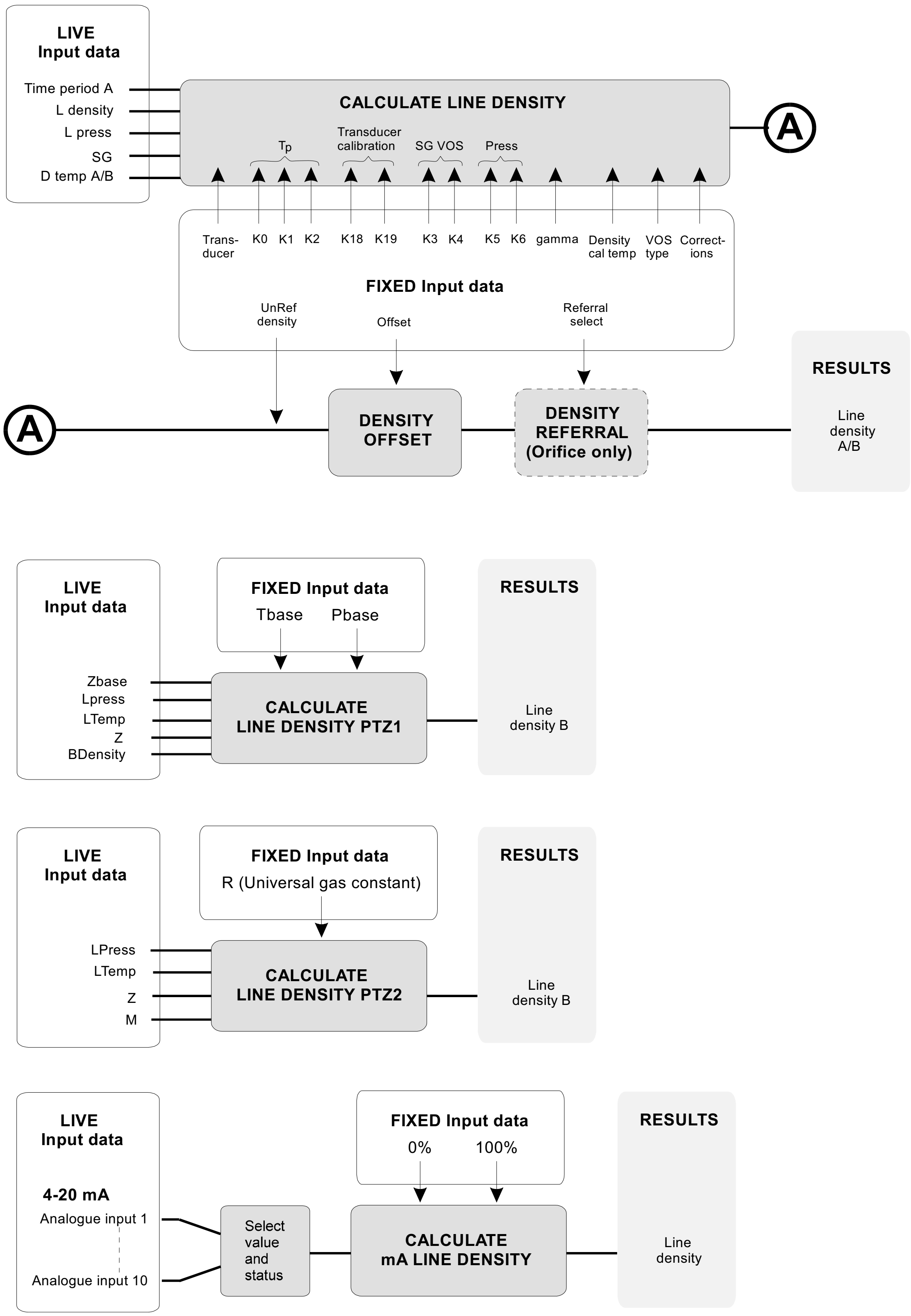
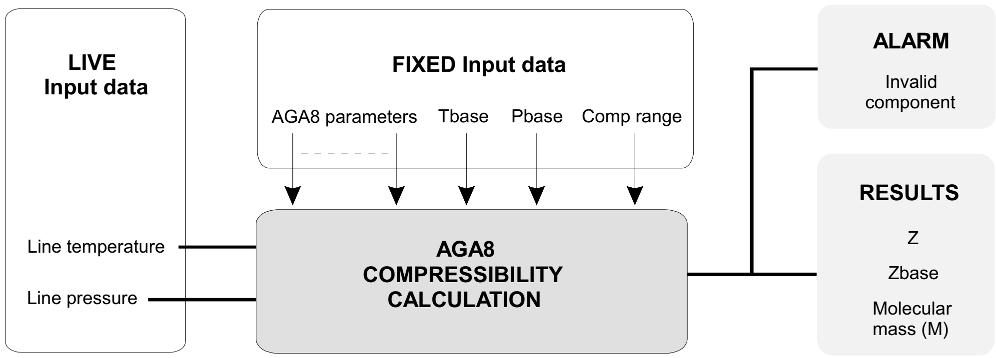


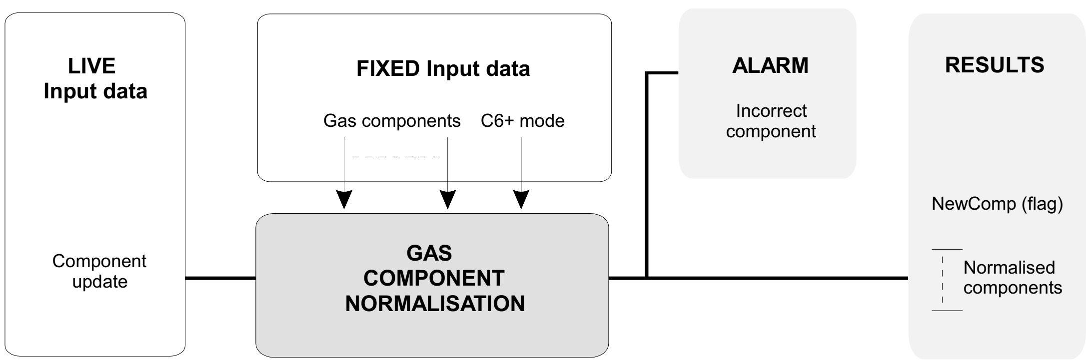
Figure 11.18 Calculating line density



Input data (normalised):

% Nitrogen	% Ethane	% n-Hexane	% Carbon monoxide
% Carbon dioxide	% Propane	% n-Decane	% Hydrogen
% Hydrogen sulphide	% n-Butane	% Argon	% C6+
% Water	% i-Butane	% n-Heptane	% n-Nonane
% Helium	% n-Pentane	% n-Octane	
% Methane	% i-Pentane	% Oxygen	

Figure 11.19 Calculating AGA8 density compressibility



Gas components:

% Nitrogen	% Ethane	% n-Hexane	% Hydrogen
% Carbon dioxide	% Propane	% n-Nonane	% C6+
% Hydrogen sulphide	% n-Butane	% n-Heptane	% n-Decane
% Water	% i-Butane	% n-Octane	
% Helium	% n-Pentane	% Oxygen	
% Methane	% i-Pentane	% Carbon monoxide	

Figure 11.20 Calculating normalisation of gas components

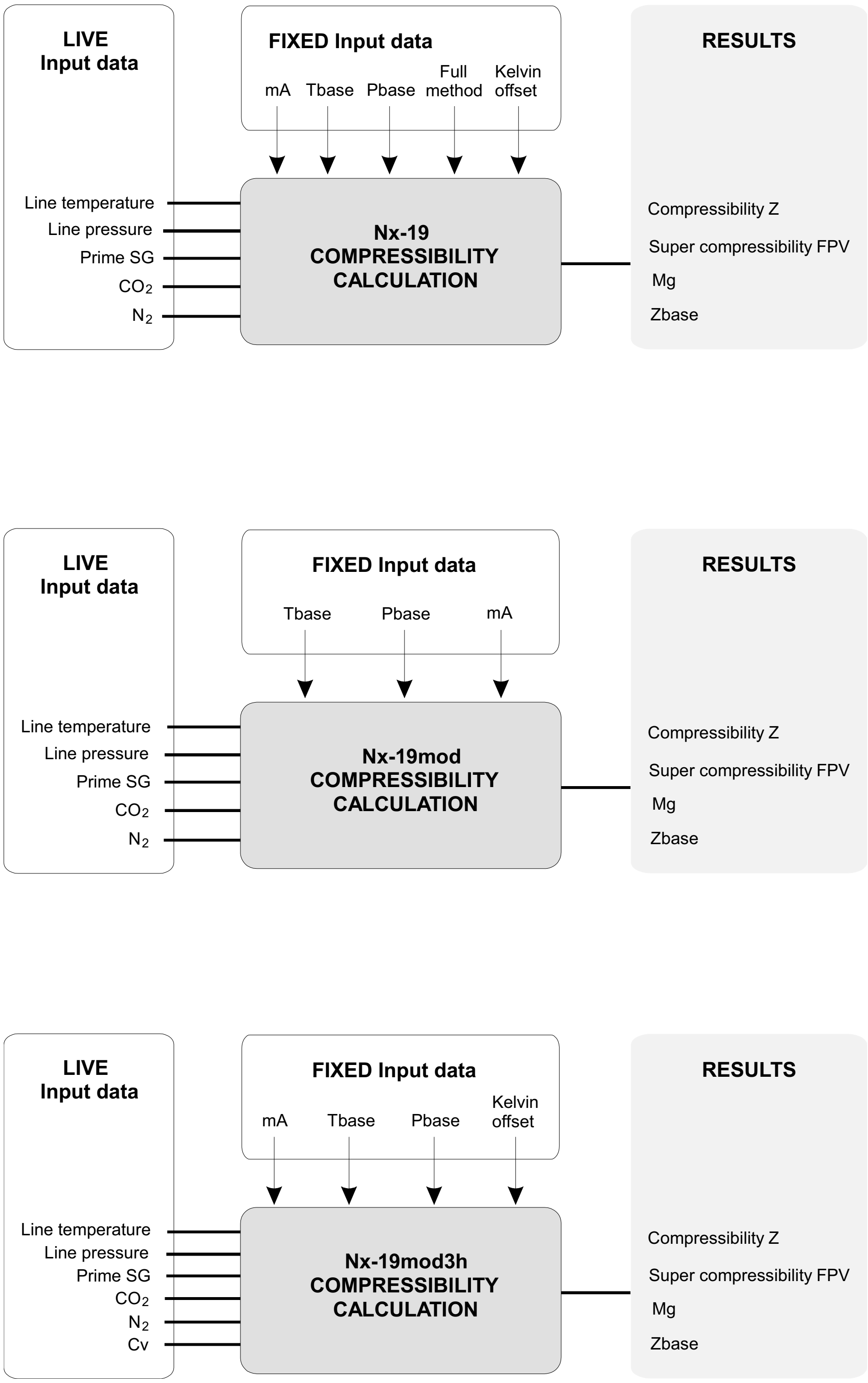


Figure 11.21 Calculating Nx-19 compressibility

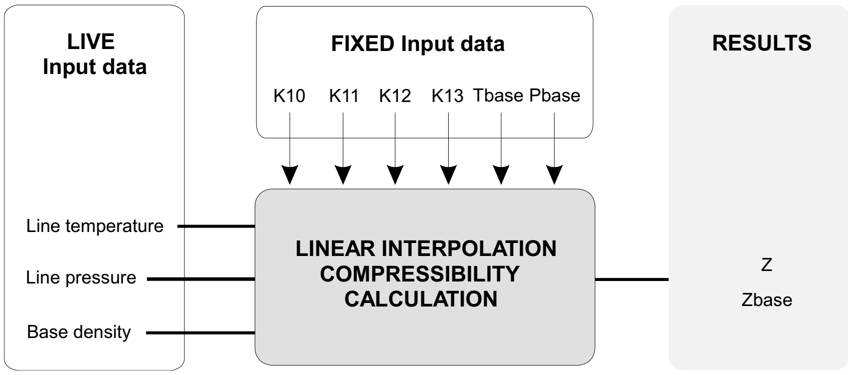


Figure 11.22 Calculating linear interpolation compressibility

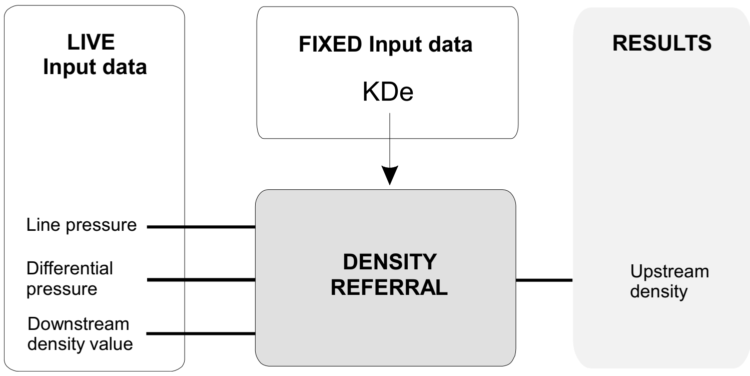


Figure 11.23 Calculating density referral

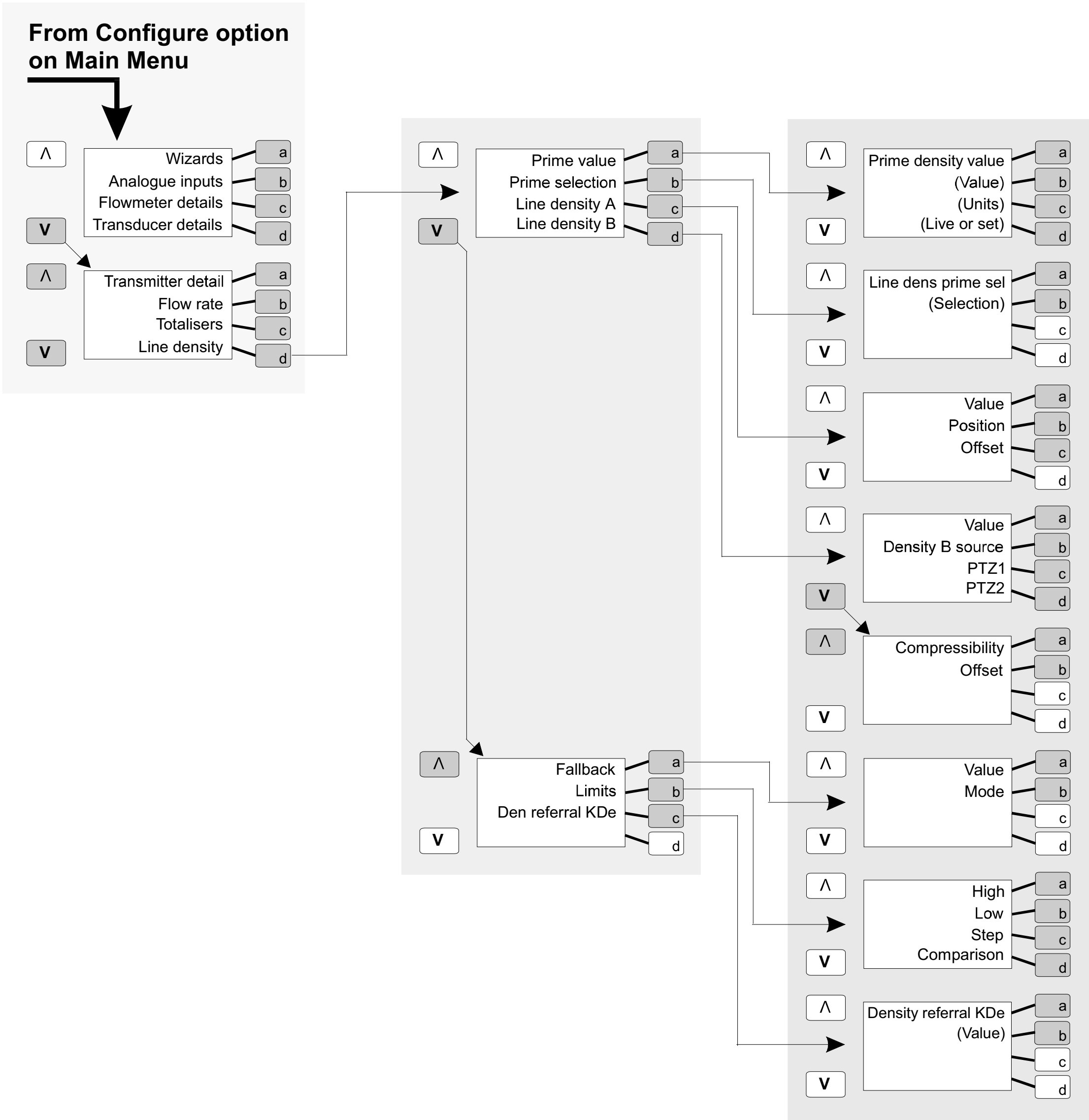


Figure 11.24 Menu structure for configuring line density

11.12 Configuring base density

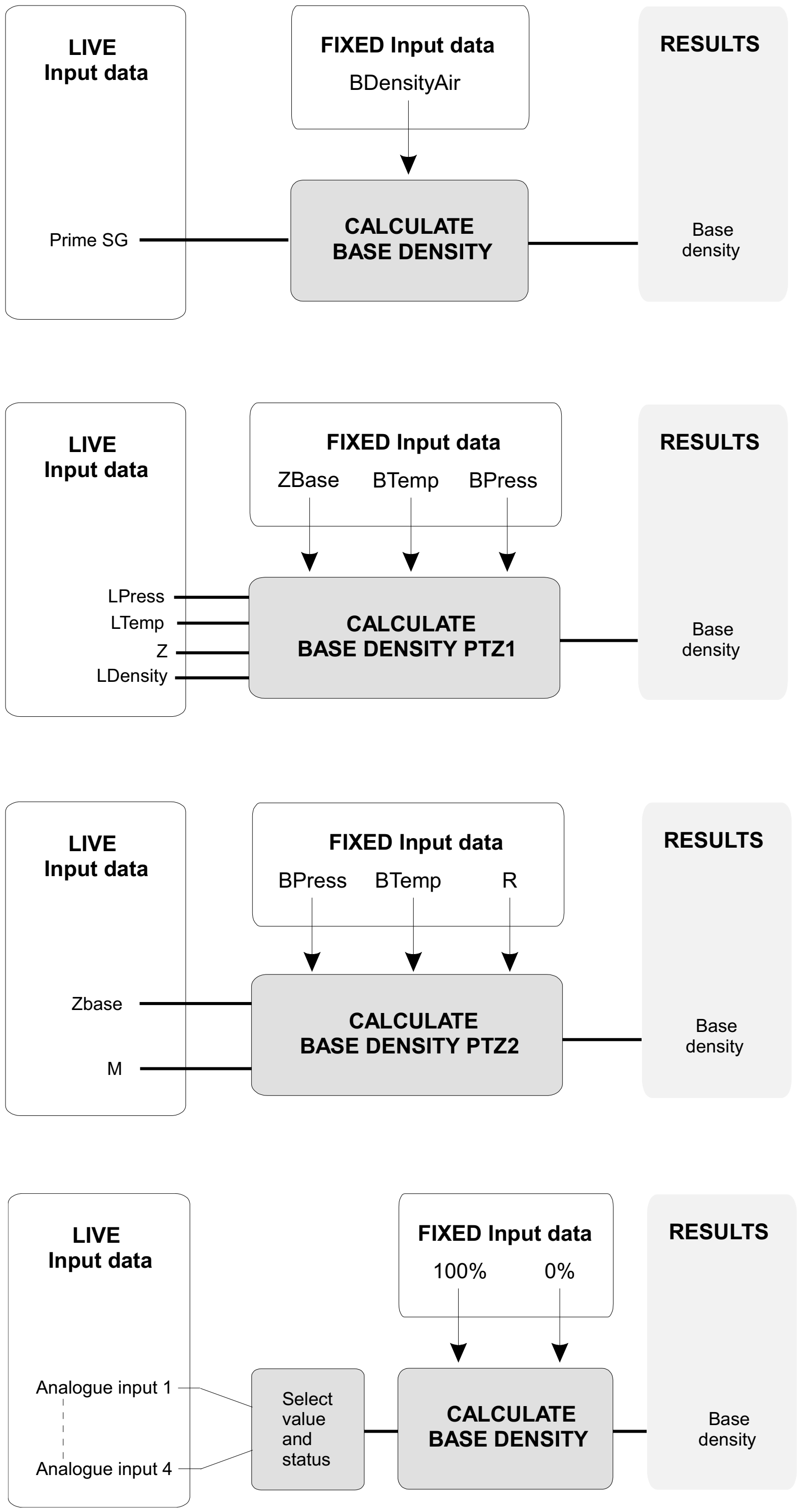


Figure 11.25 Base density

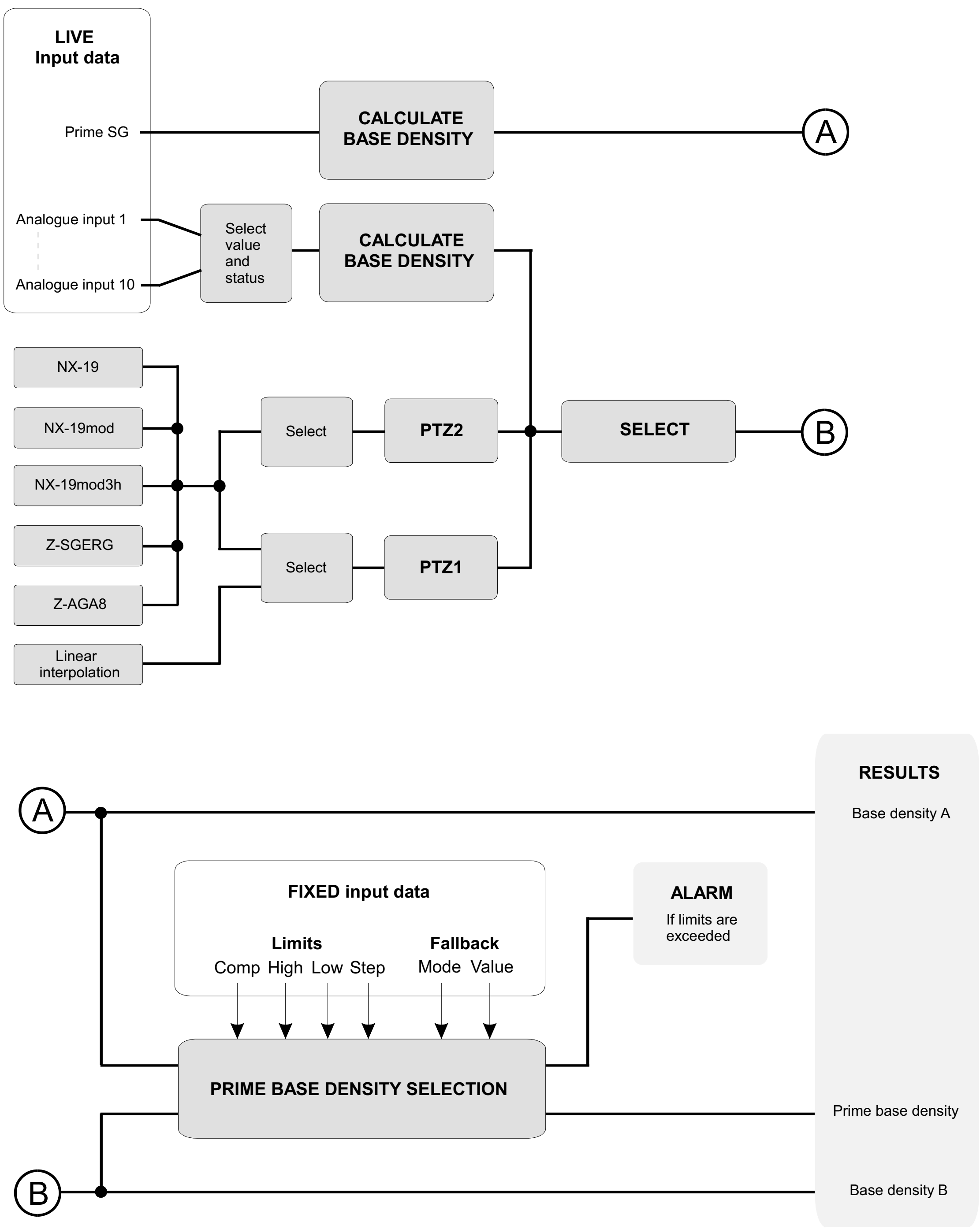


Figure 11.26 Calculating base density

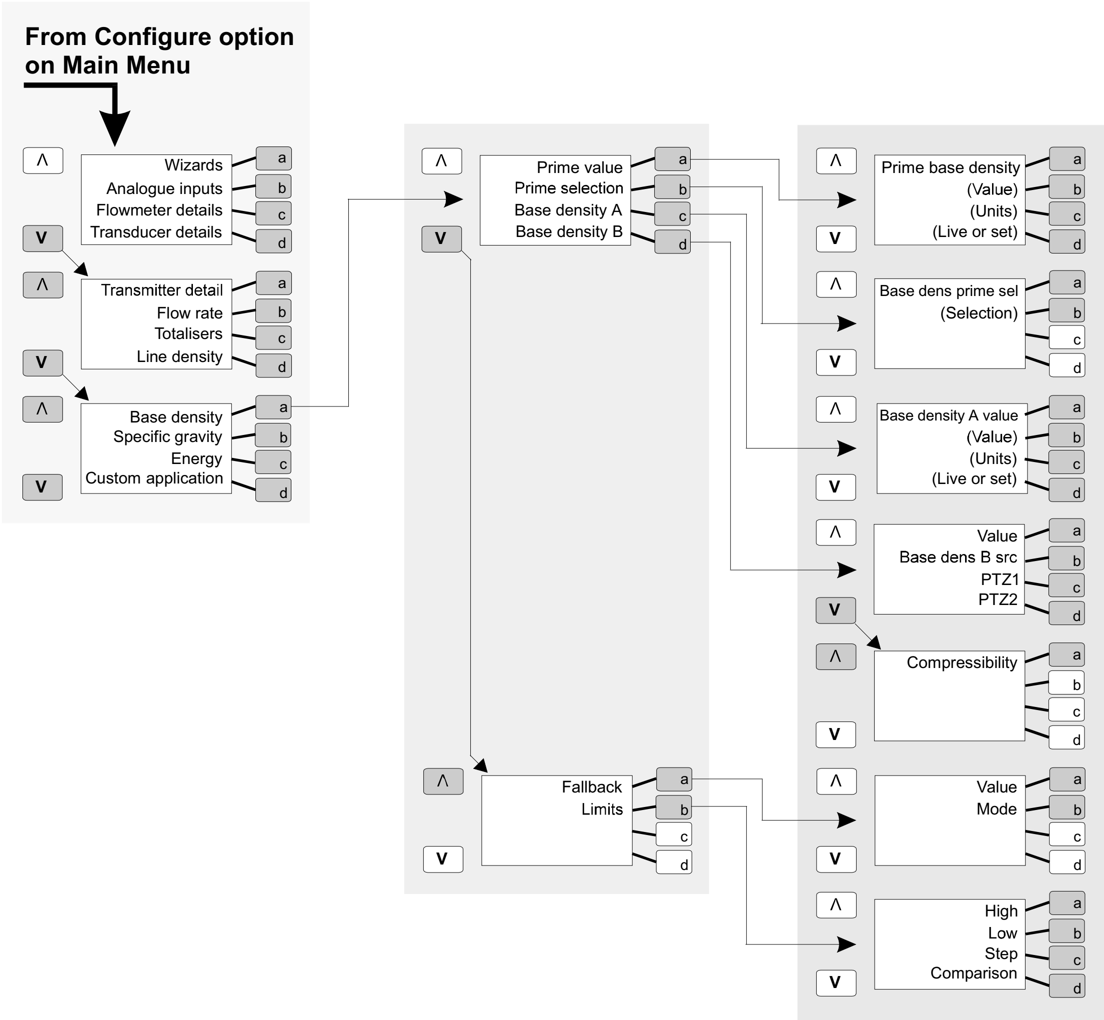


Figure 11.27 Menu structure for configuring base density

11.13 Configuring specific gravity

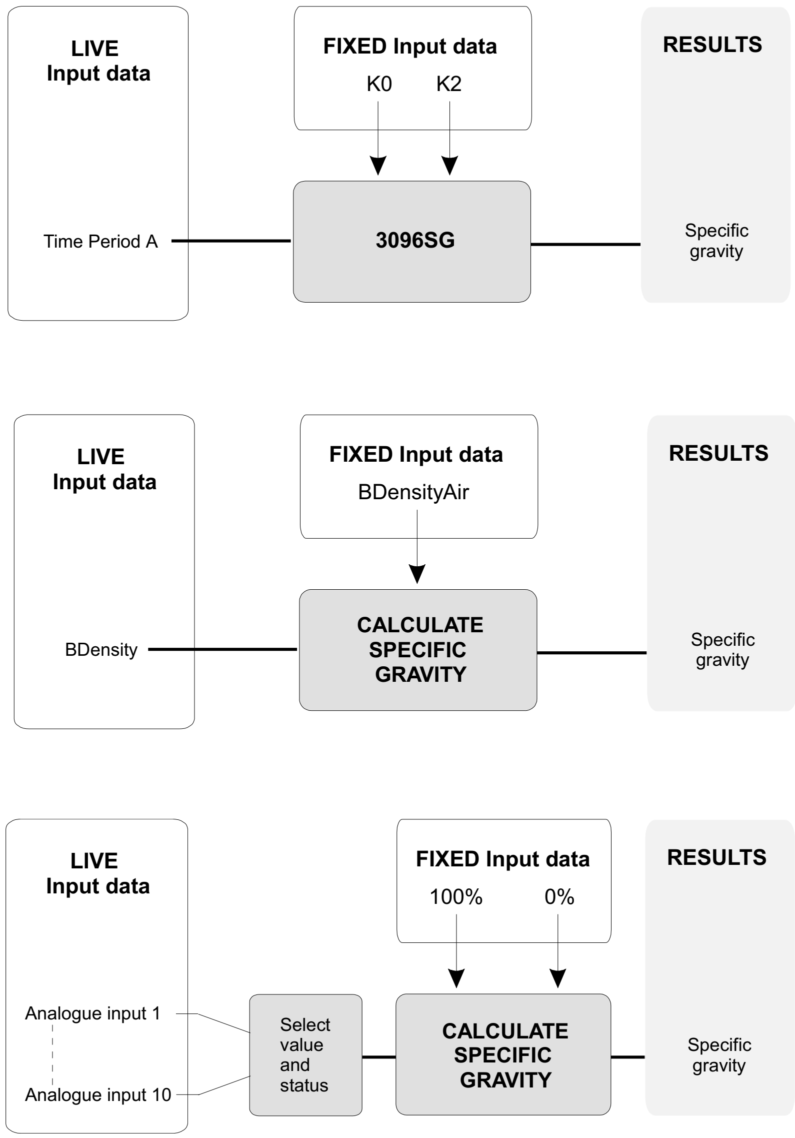


Figure 11.28 Calculating specific gravity

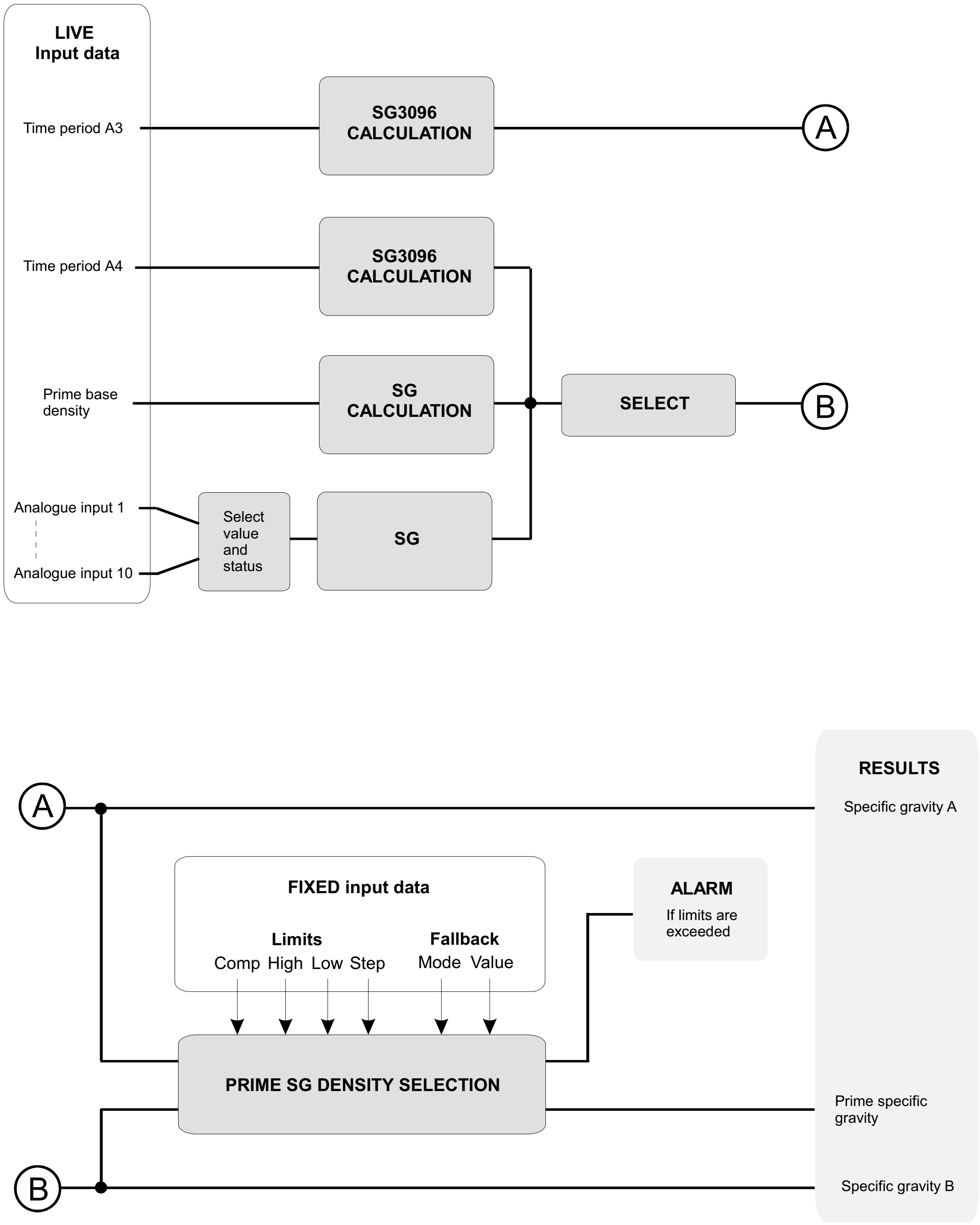


Figure 11.29 Calculating specific gravity

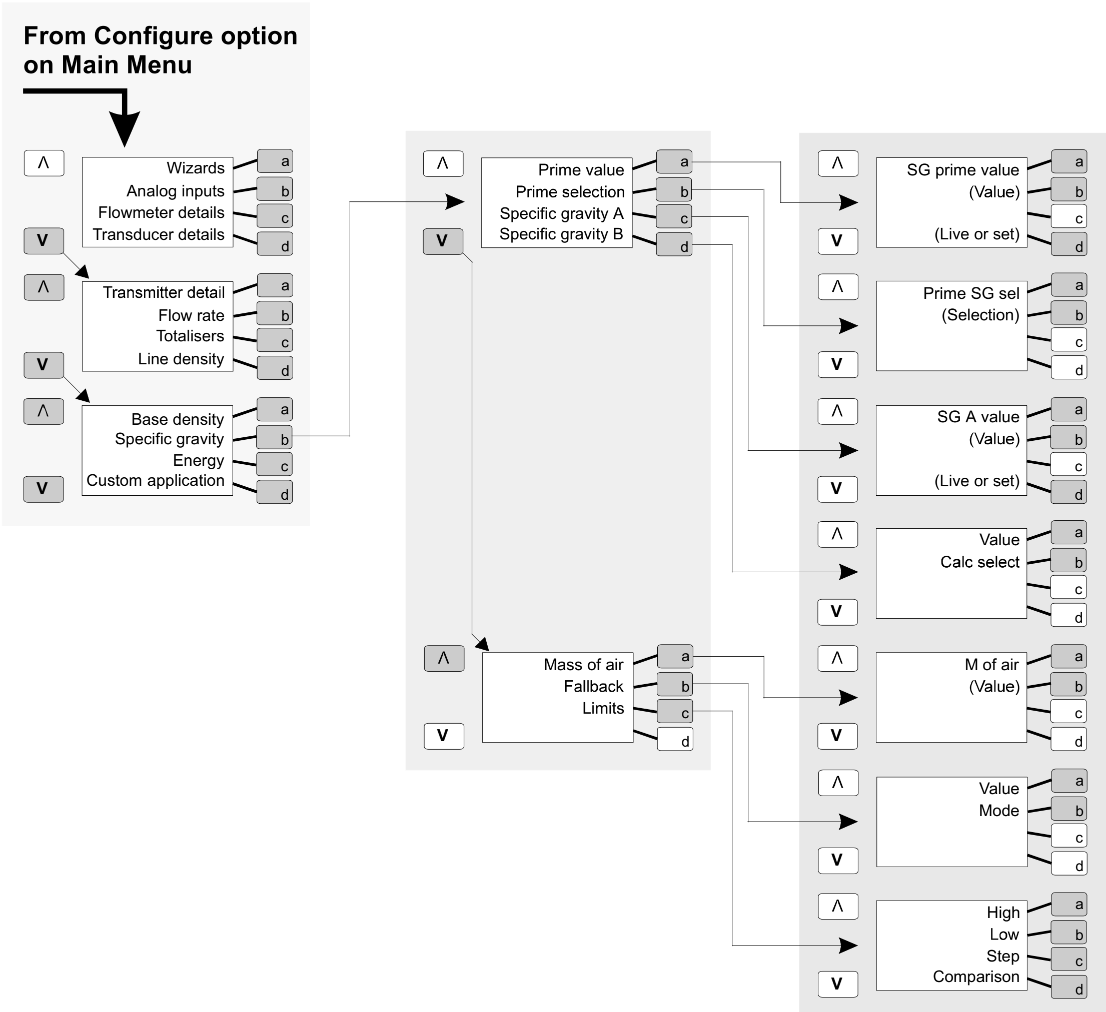


Figure 11.30 Menu structure for configuring specific gravity

11.14 Configuring energy

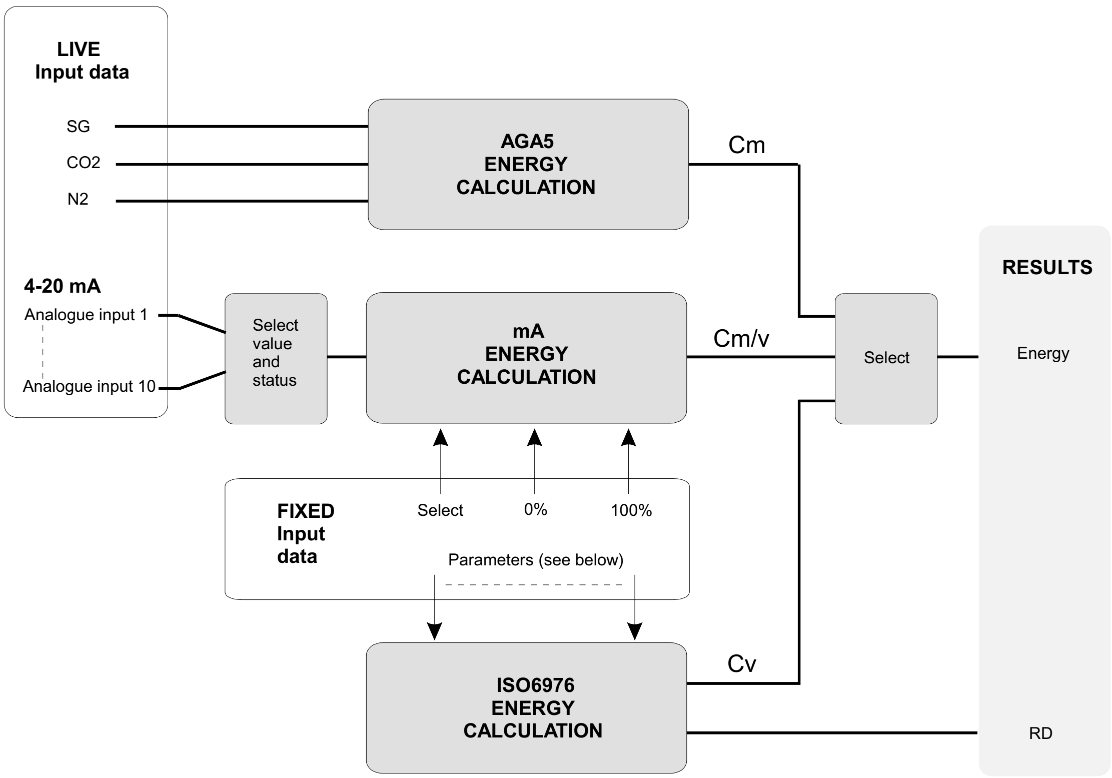


Figure 11.31 Calculating energy

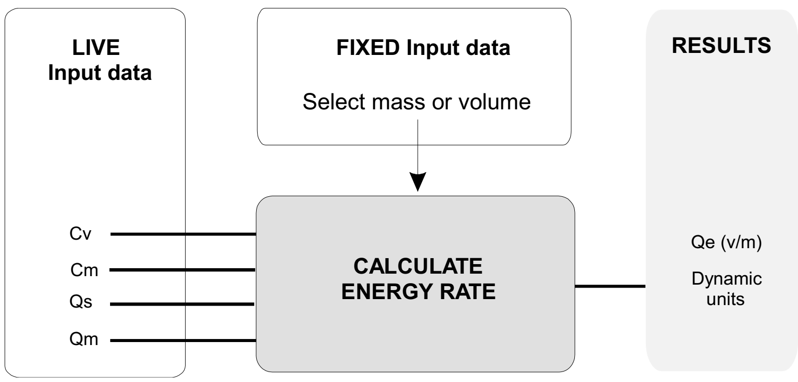


Figure 11.32 Calculating energy flow rate

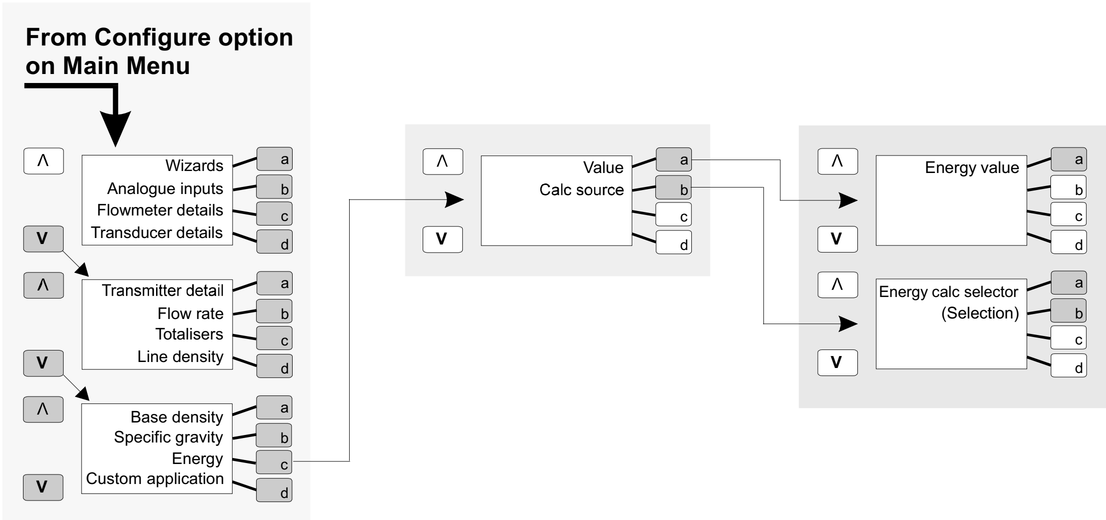


Figure 11.33 Menu structure for configuring energy

11.15 Configuring custom applications

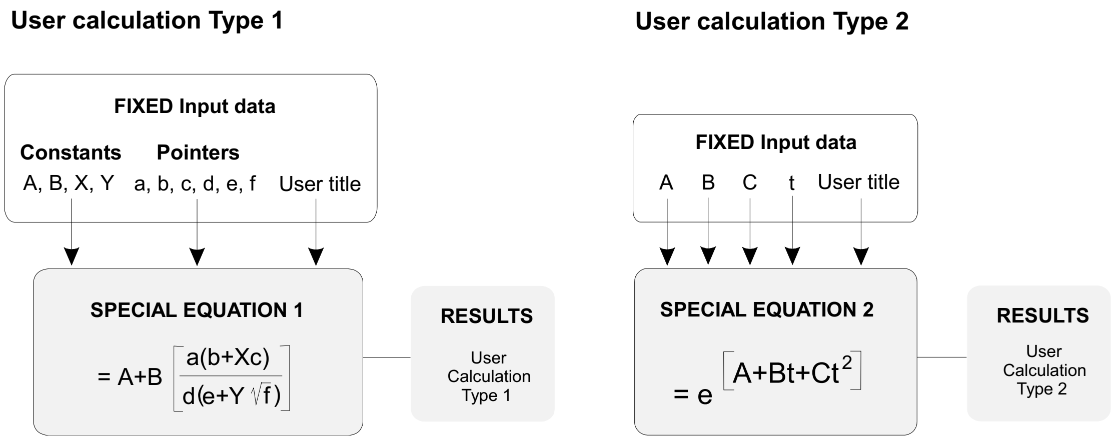


Figure 11.34 Calculating custom applications

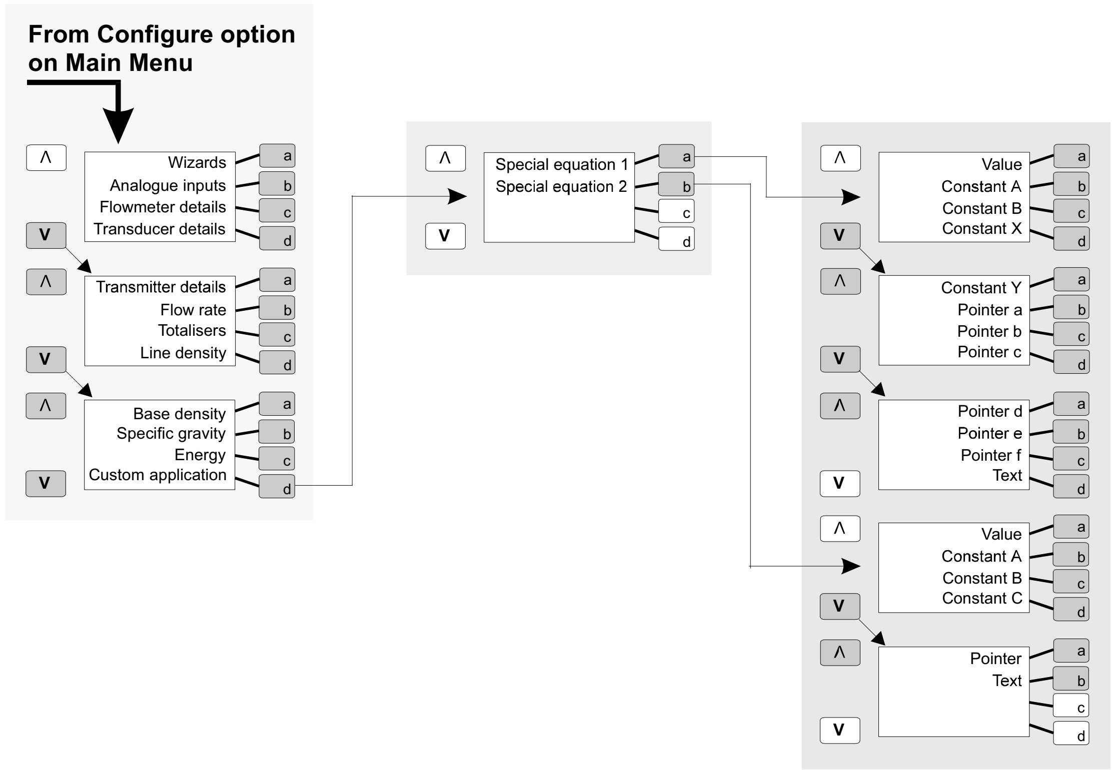


Figure 11.35 Menu structure for configuring custom applications

11.16 Configuring mA outputs

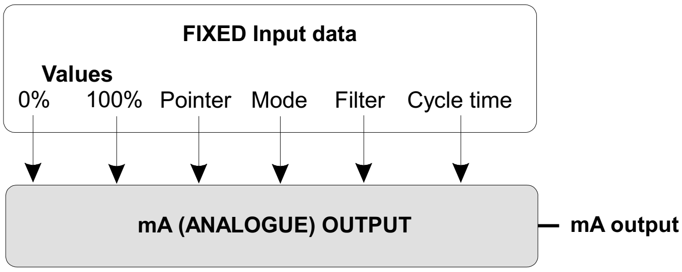


Figure 11.36 mA outputs

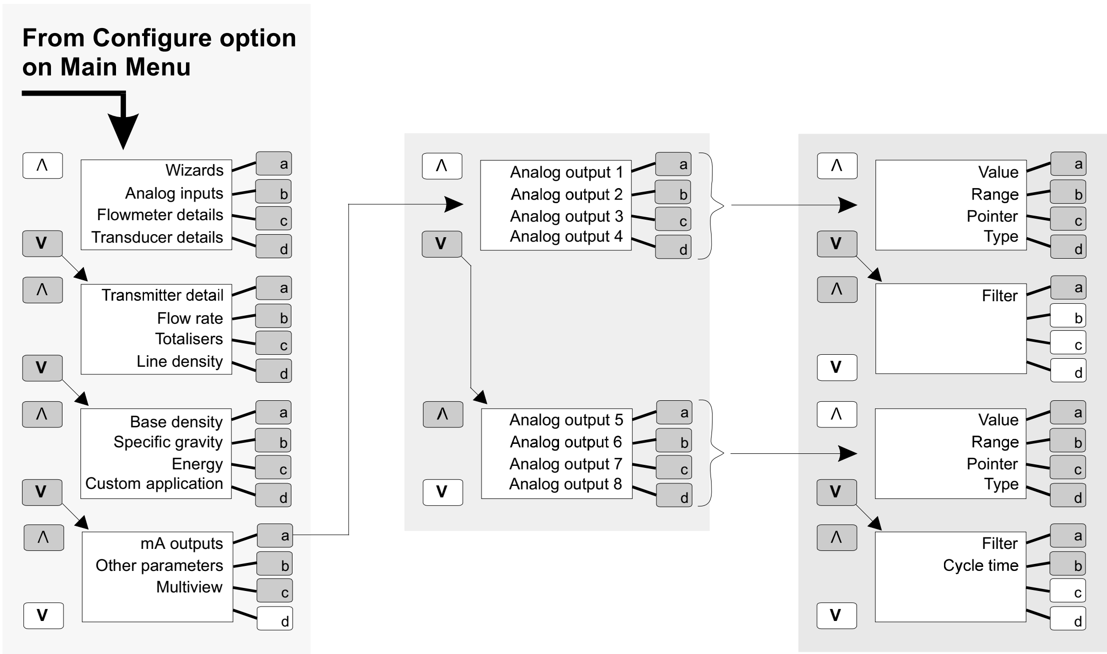


Figure 11.37 Menu structure for configuring mA outputs

11.17 Configuring other parameters

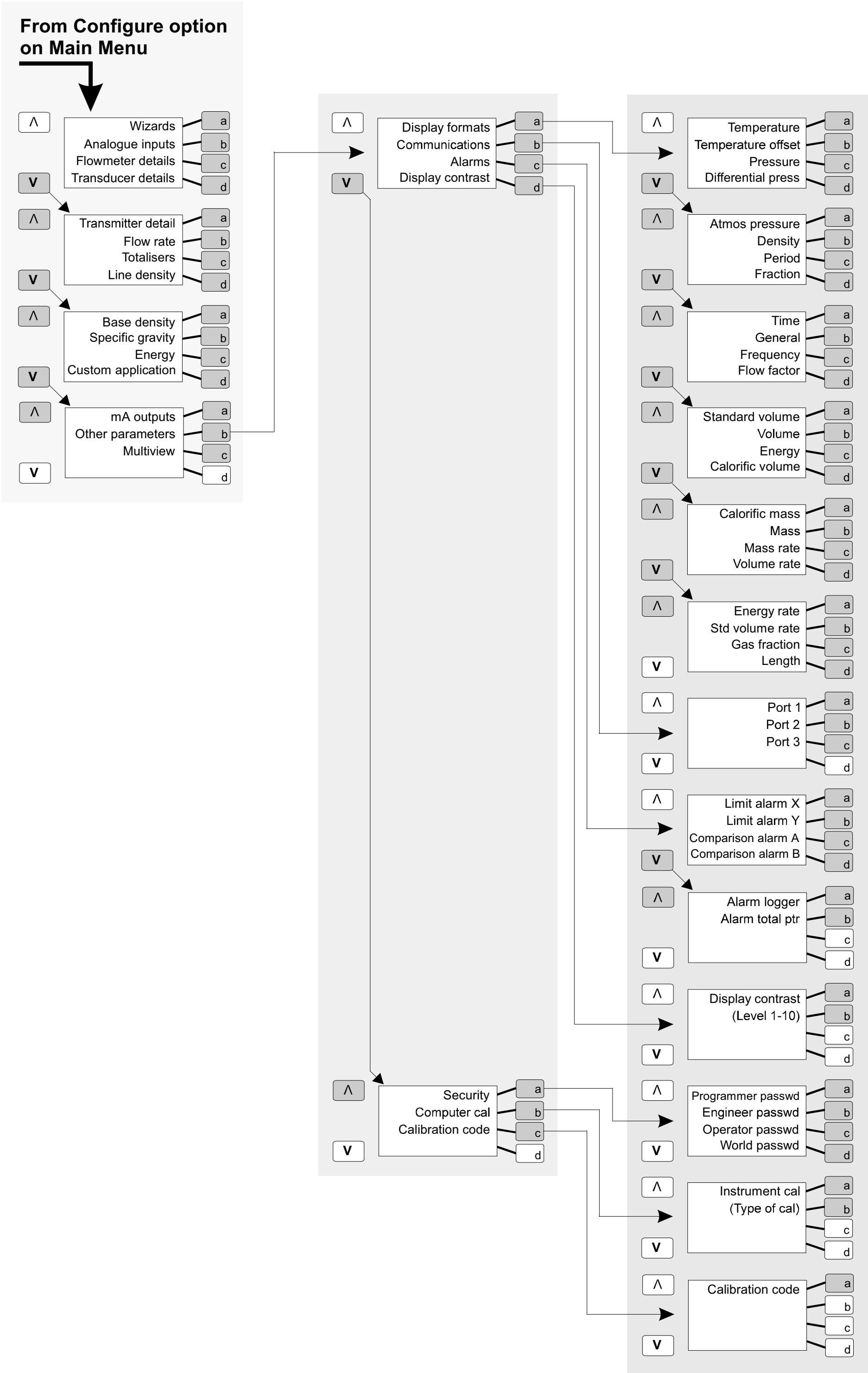


Figure 11.38 Menu structure for configuring other parameters

What the “Other parameters” option does

Selecting “Other parameters” brings up the following options:

- **Display formats**
  Lets you specify, for each parameter: The units which are used, together with the number of decimal places or exponential format for the value.
- **Alarms**
  Alarms are dealt with in chapter 8.
- **Communications**
  Lets you set up all aspects of communications, including:
  - the function of each port.
  - baud rates.
  - character formats.
  - handshake protocol.
  - MODBUS parameters (slave address, dialect and mode).
- **Display contrast**
  Lets you set the contrast between the text and background on the display. Contrast is on a scale of 1-10; the higher the number, the darker the contrast.
- **Security**
  Use this option to set passwords. This is explained later in this section.
- **Computer calibration**
  This is used to calibrate instruments connected to the 795x. **DO NOT CHANGE THESE SETTINGS UNDER ANY CIRCUMSTANCES. IF YOU DO, YOU *CANNOT* CHANGE THEM BACK WITHOUT USING SPECIALISED CALIBRATION EQUIPMENT.**

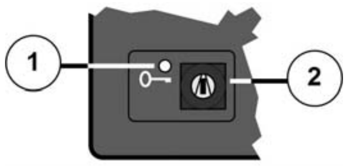
Passwords and security

Securable and non-secure modes

The 7951 can work in a **non-secure** or **securable mode**. In non-secure mode, anyone can have access to any of the facilities. In securable mode, access to facilities can be protected by passwords.

Changing security mode

On the 7951 you change the security mode by using the key switch on the front of the instrument. The instruments are normally securable but, when you insert the key and turn it clockwise, this changes the mode to non-secure. You can only withdraw the key in the vertical (securable) position.



1. Security Level LED. **2.** Security Lock

Figure 11.39 The security lock on the 7951

Security levels

The password system restricts access to its facilities to those people with certain levels of authority. There are four levels of security:

- Calibration.
- Engineer.
- Operator.
- World (anyone other than those listed above).

The table below lists what facilities each of these groups can access.

	Access levels			
Facilities available	**Programmer**	**Engineer**	**Operator**	**World**
Calibration facilities	YES	NO	NO	NO
Programmable parameters except security codes	YES	YES	NO	NO
Security codes	YES	NO	NO	NO
How the security LED appears	RED flashing	RED	ORANGE	GREEN

Note: Some versions of 795x software do have a "Operator" level that can change limits.

Switching between levels

This is achieved by selecting the "Password" option (from the main menu) and then entering the appropriate security code for the level required. A correctly entered security code will cause the access the level to change. However, an incorrectly entered security code will change the access level to "World".

Setting or changing a password
This can only be done when the present access level is "Programmer".

From the main menu, select the "Other parameters" option. Next, select the "Security" option. Choose the password option (i.e. Programmer, Engineer, Operator or World) you want to set or change, then type in a password of up to 20 characters. If there is an existing password you can clear it first by pressing the **CLR** button.

You can, if you wish, have the same password for more than one level. This gives you access to the facilities of all the levels covered by that password.

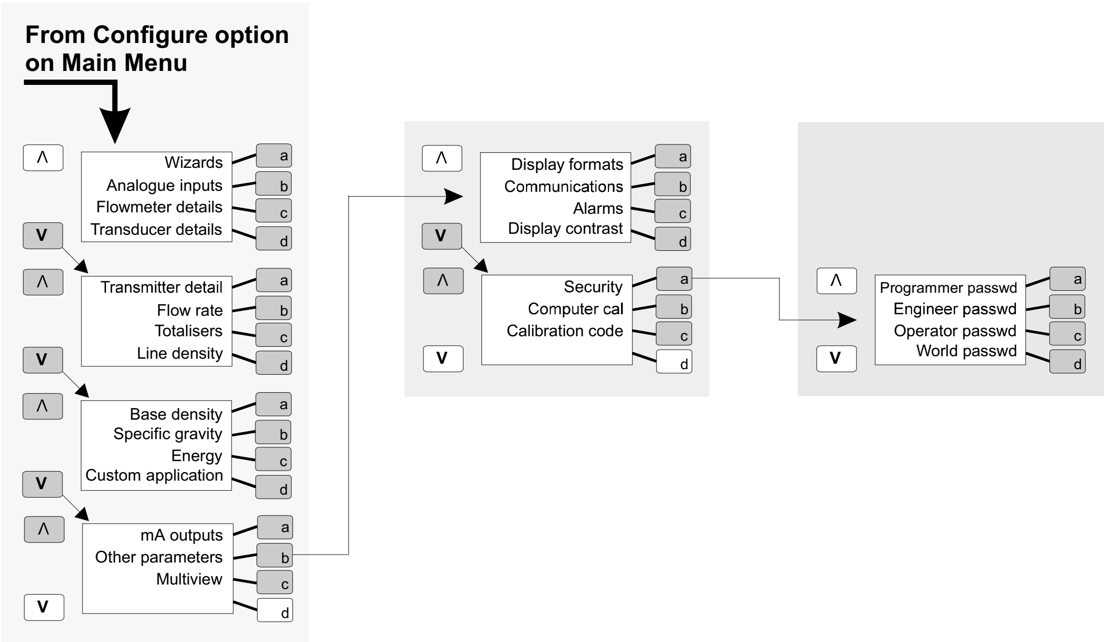


Figure 11.40 Where to enter passwords

11.18 Configuring Multiview

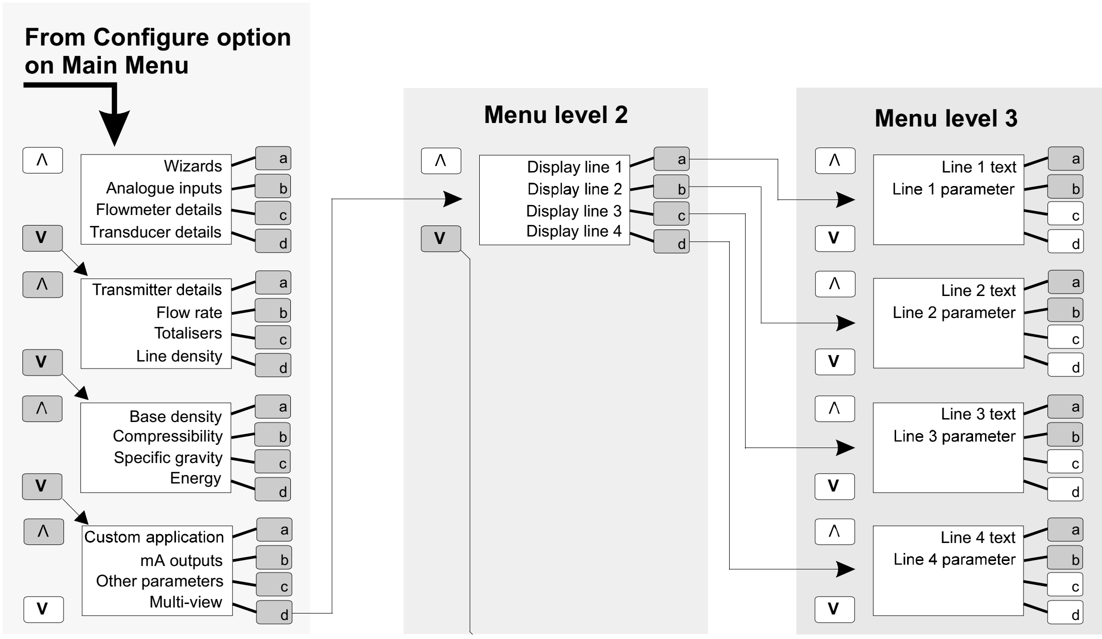


Figure 11.41 Menu structure for configuring Multiview

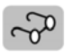
What is Multiview?

Multiview (often referred to as the "User Display") is a display which you define to show whatever information you want. It consists of up to four lines which comprise either or both of:

- Text (such as the name of a parameter), at the left of the line.
- A value for a parameter, at the right of the line.

You can change the configuration of Multiview displays whenever you wish. An example of a typical Multiview display is shown on Page 11.37.

How to get into Multiview



To see the Multiview display, press the **Multi-view DISPLAY** button. The Multiview display looks like the example below.

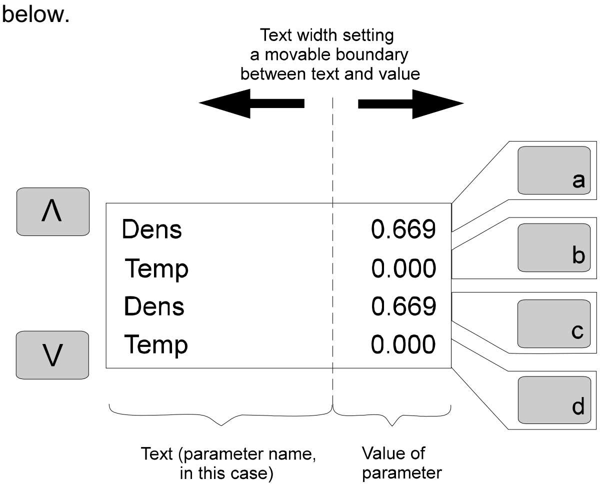


Figure 11.42 A typical Multiview display

Configuring Multiview

Outline of the procedure for configuring Multiview:

Step 1: Decide what text you want to display

You almost certainly want each line of the Multiview display to show the name (possibly in an abbreviated form) of a parameter whose value you want to display. Bear in mind that:

- Text cannot exceed 11 characters.
- The display leaves a space between the text and value.
- The value is displayed as a number *without* any units. You may wish to include the units as part of the text.

Step 2: Find the location IDs of the parameters

1. In the menu system, find the parameter you want.
2. Press the **a** key to display the location ID.
3. Note down the location ID.
4. Repeat this for the other parameters.

For example: To find the ID of the location where Line Density is stored, go to the Level 3 menu headed "Line density value". The display looks like this:

Step 3: Open the Multiview configuration menu

Open the Multiview configuration menu as shown in the diagram on Page 11.37.

Step 4: Entering the text and location ID for each line

1. Select whichever line (1 - 4) you want to configure.
2. Enter the text you require.
3. Enter the parameter (location ID) you require.

Note that after the location ID is entered, the display changes to show the name of the parameter.

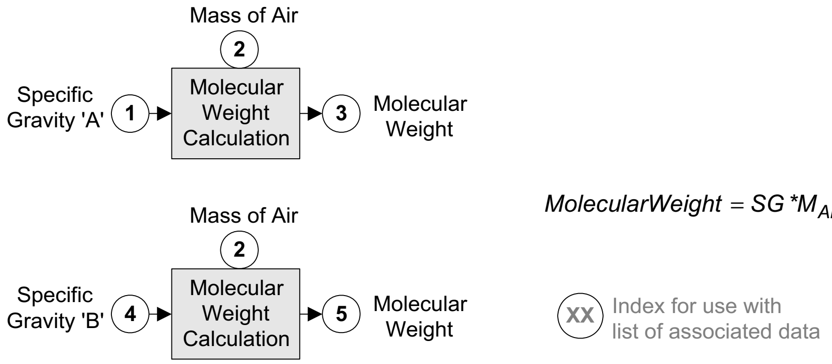
Step 5: Set the text width

The text width is the number of characters you want the text to occupy. If you want to set the text width:

1. Go to the Text width menu.
2. Edit the value

Molecular Weight of Gas Calculation

The molecular weight of gas in the stream can be calculated independently of the compressibility calculations.



$$MolecularWeight = SG * M_{Air}$$

Data shown in the diagram and listed below can be found by looking within these menus:
(**A**) <“Configure”>/<“Specific gravity”> and (**B**) <“Specific gravity”>

Data associated with the block drawing:

* shows data that can be “Live” or “Set”

Index	Parameters (*as displayed*)	Notes?
1	SG A*	
2	Mass of Air	
3	Molecular Weight A*	

Index	Parameters (*as displayed*)	Notes?
4	SG B*	
5	Molecular Weight B*	

12. Routine operation

12.1 What this chapter tells you

This chapter tells you how to carry out all those procedures which are a part of the normal operation of the 795x. It does not cover configuration, servicing or repair. These topics are dealt with elsewhere in this manual.

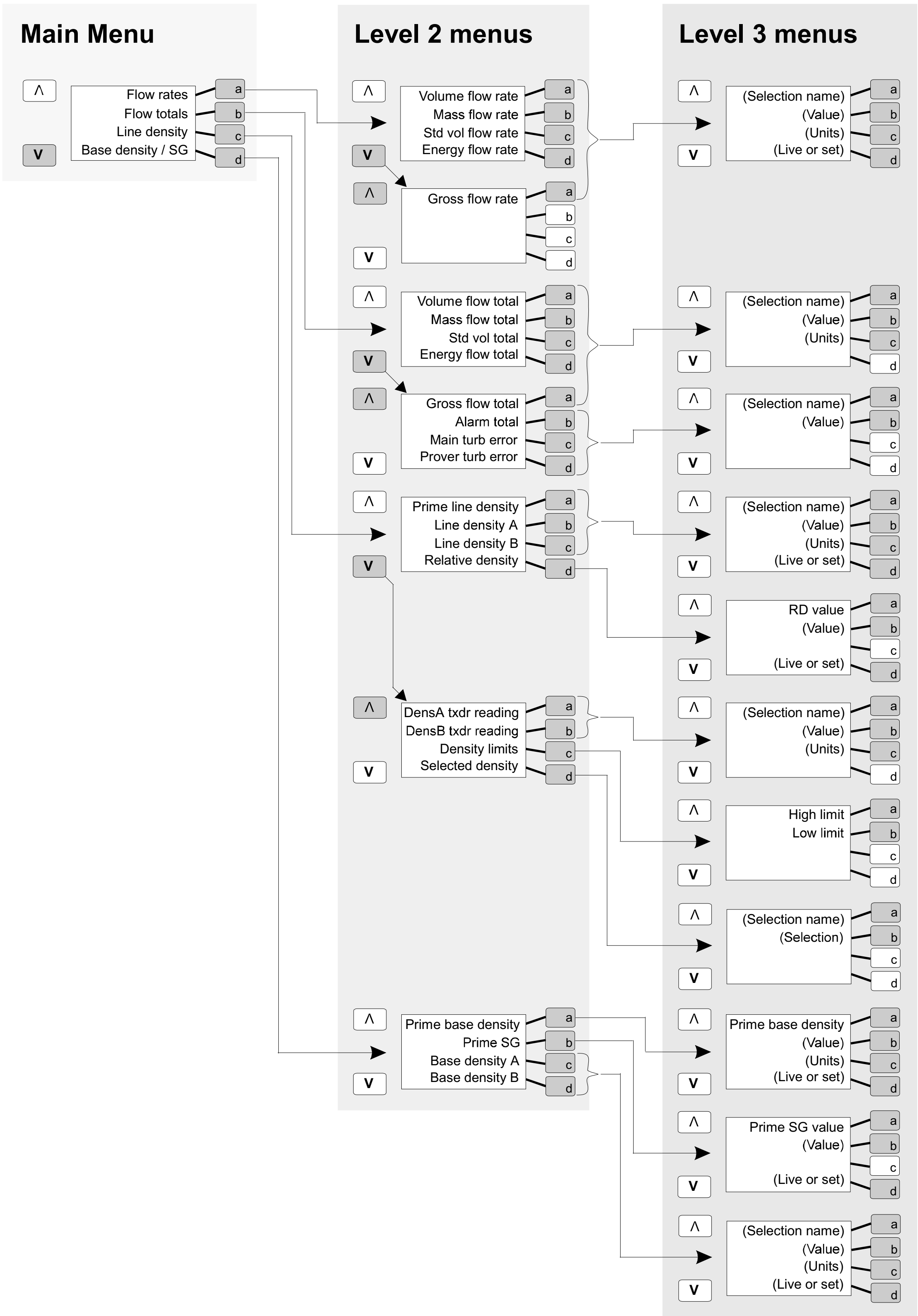
12.2 Viewing the data

The diagrams on the following pages show that part of the menu structure which you use to carry out many of the procedures described in this chapter.

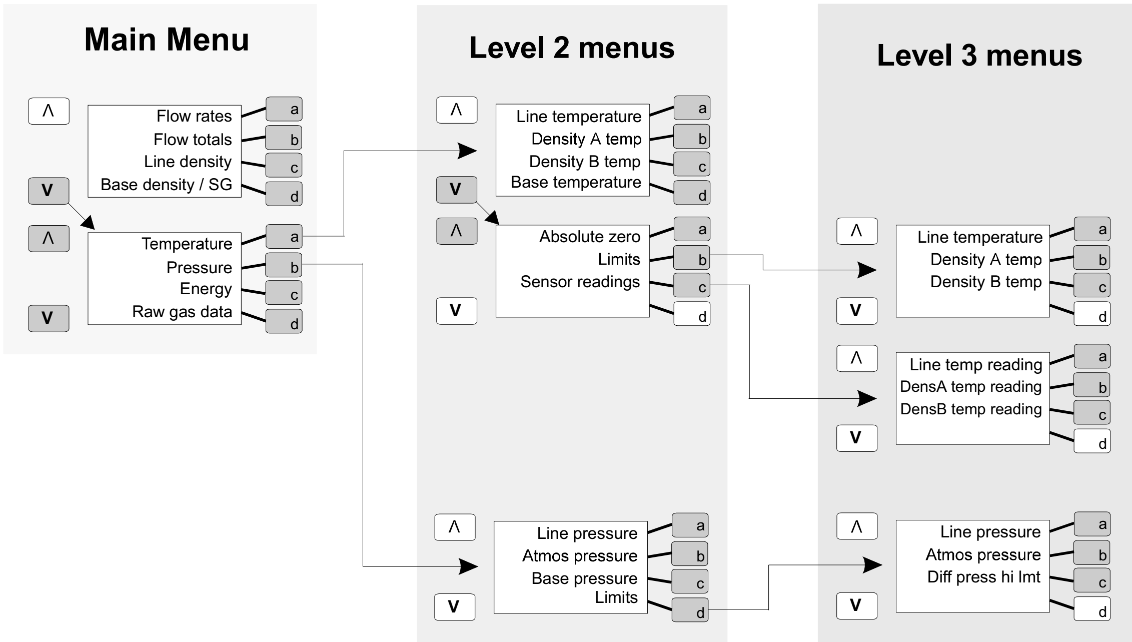
The diagrams show the first, second and third levels of the menu structure except for that part which is concerned with configuration, which is covered in a separate chapter.

Where an item is shown in brackets, the actual value or setting appears at this point. The most common examples are:

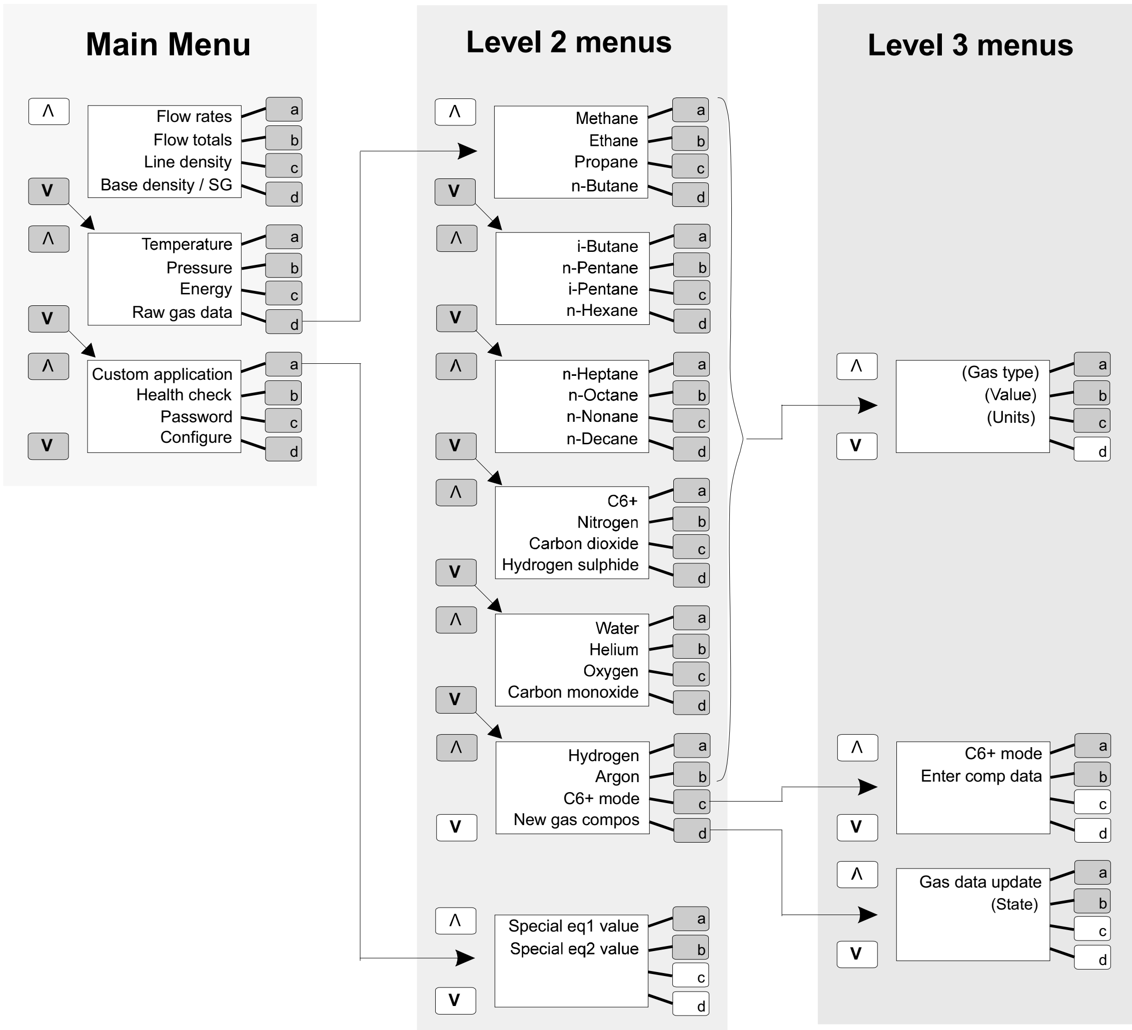
(Value)	The display shows the actual value of the parameter.
(Units)	The display shows the actual units.
(Live or set)	The display shows either LIVE or SET according to the setting of the input.



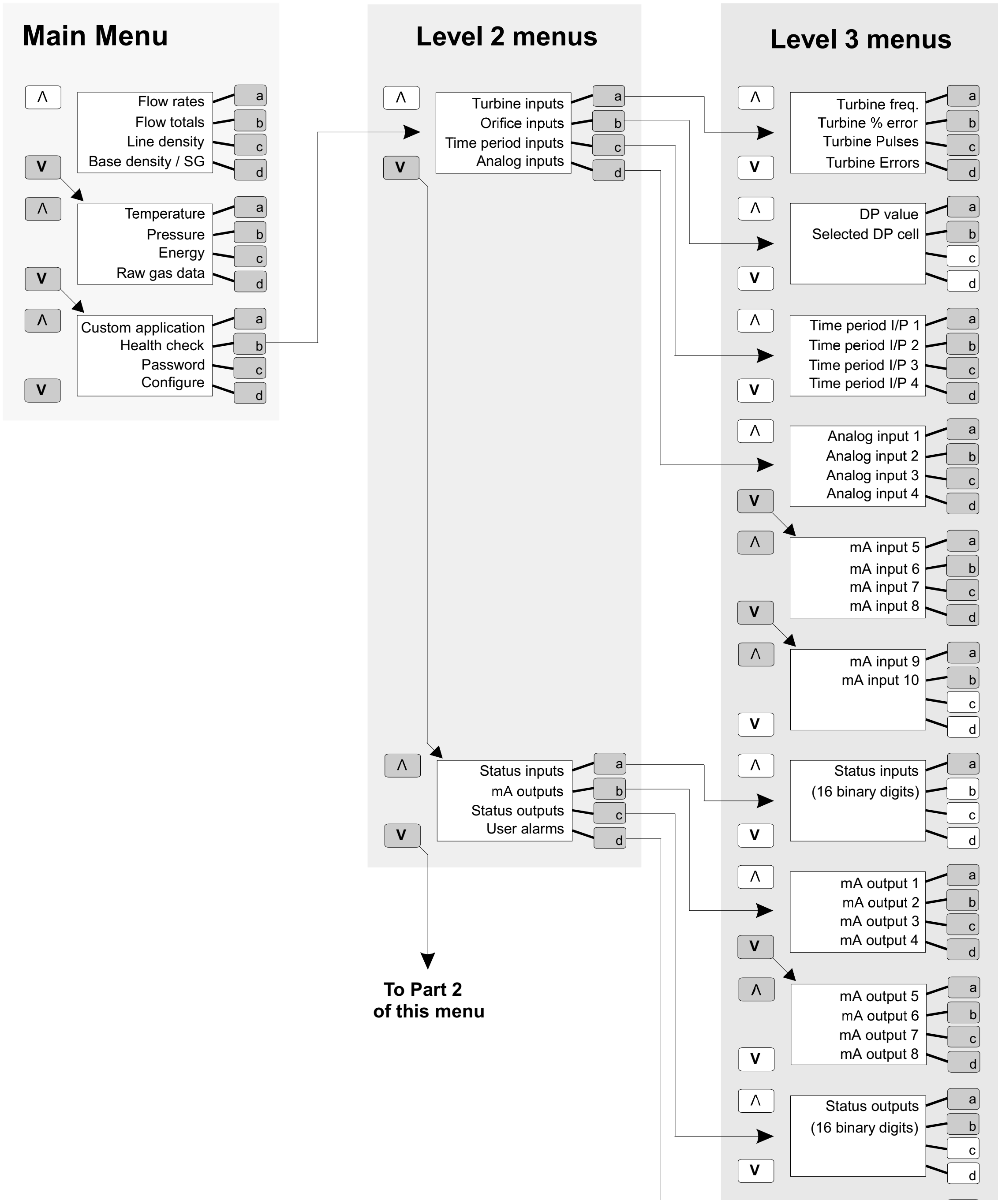
Menu structure: Flow rates, flow totals, line density and base density/SG



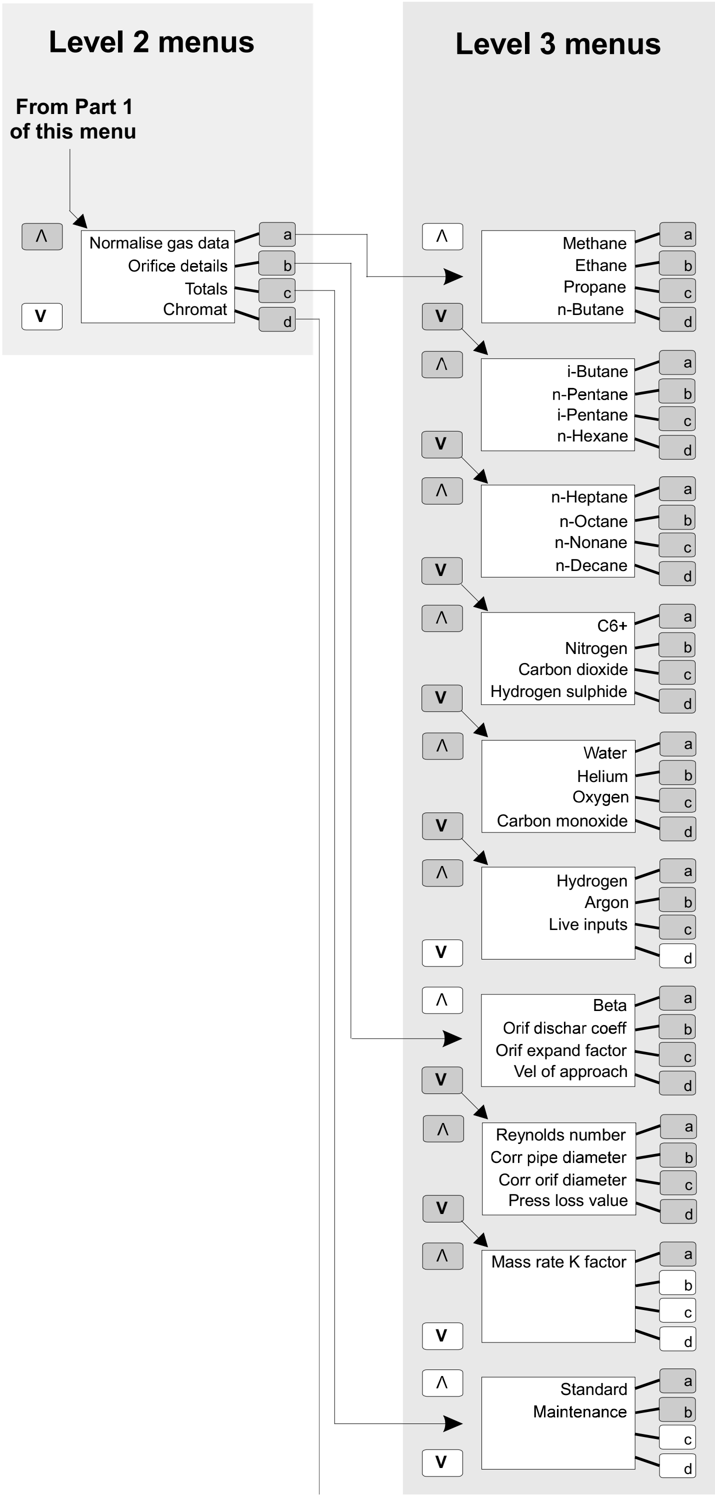
Menu structure: Temperature, pressure and energy



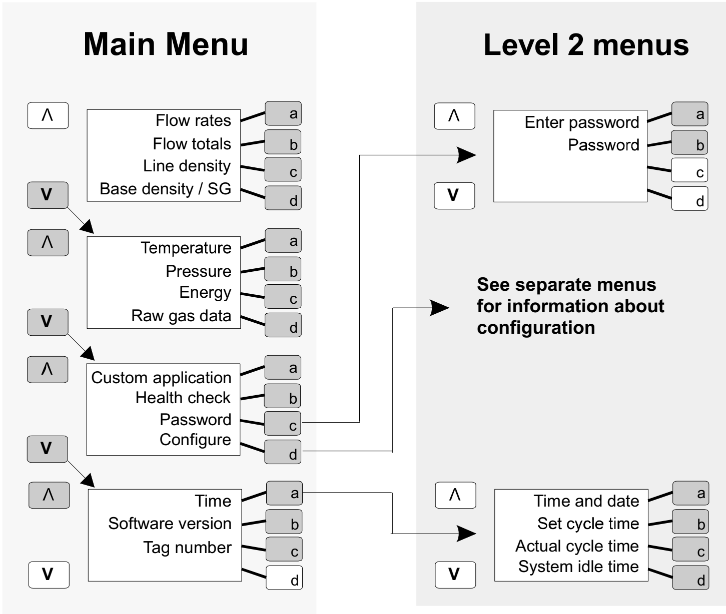
Menu structure: Raw gas data and custom application



Menu structure: Health check Part 1



Menu structure: Health check Part 2



Menu structure: Password, time, software version and unit ID

12.3 Security and passwords

For more information about setting and changing passwords, and security in general, refer to chapter 10.

12.4 How you can edit displayed information

The figure shows a typical display showing information about the inputs and outputs.

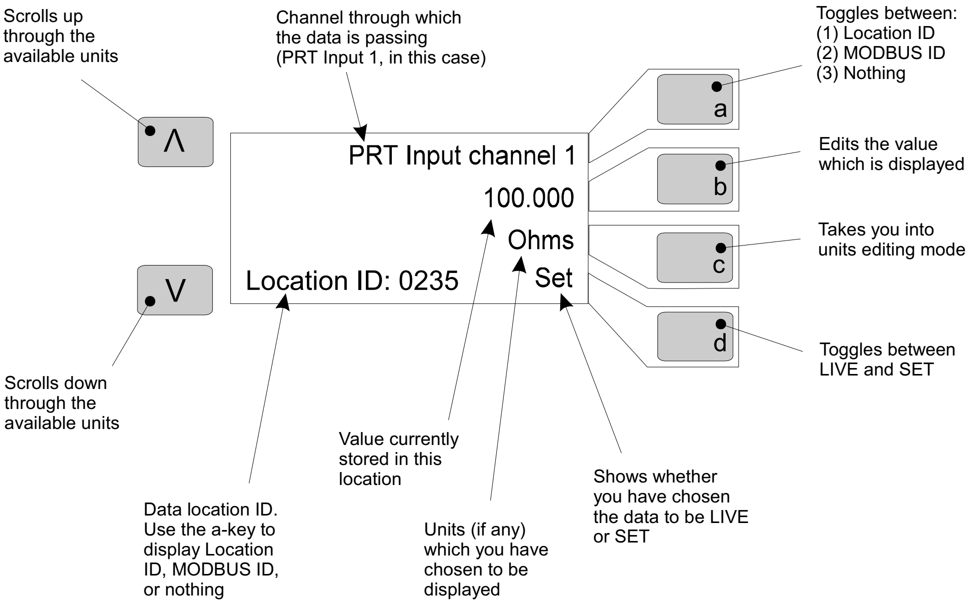


Figure 12.1 A typical data display

You can edit some of this information by:

- Making the data LIVE or SET.
- Changing the units which are displayed.
- Changing the value which is displayed.

There are limits on what the display shows and, as a result, what you can edit.
For example, Atmospheric Pressure has a value and units and can be made live or set. On the other hand, you cannot SET the Alarm Total (there is no point in doing so), neither can you display units for it.

12.5 Making data values Live or Set

To make any value live or set:
Go to the menu which displays the parameter, its value and units (where applicable). Toggle the **d-button** to show **LIVE** or **SET** as you wish. For example, to set the value for Prime Base Density:

1. Refer to the first Menu Structure diagram.
2. Go to the Level 3 menu which is headed **PRIME BASE DENSITY**.
3. Press the **d-button**. This toggles between **LIVE** and **SET**. Leave it on whichever setting you want.

12.6 Changing the units which are displayed

To change the displayed units:

1. Go to the menu which displays the parameter, its value and units.
2. Press the **c-button**. The name of the unit currently in use shifts to the left of the display.
3. Press the **UP-ARROW** or **DOWN-ARROW** button to scroll through the list of units. Stop at the one you want.
4. Press the **c-button**. The unit you have selected shifts back to the right of the display.

12.7 Changing fallback values

To change the fallback values:

1. Go to the menu which displays the parameter, its value and units.
2. Press the **b-button**. The value currently displayed shifts to the left of the display.
3. Input the value you want. This over-types the existing value.
4. Press the **b-button**. The value you have entered shifts back to the right of the display.

12.8 Changing the time and date

To change the time and date:

1. Go to the Level 3 menu where the time and date are displayed.
2. Press the **b-button**. The time and date currently displayed shifts to the left of the display.
3. Input the new date and time. This over-types the existing figures.
4. Press the **b-button**. The new details shift back to the right of the display.

12.9 Checking the performance of the 795x

If you want to check that the external connections are working properly, the Health Check facility can help you. It shows, for each external connection:

- the name of the input or output
- the value of the data
- the units for the data
- whether the data is live or set
- the Modbus or location ID, or nothing.

If the data is live but the value appears to be unusually high or low, this may be because the external connection is not working properly.

12.10 Giving your 795x a tag number

If you have more than one 795x you may want to give each instrument a tag number so that, in printed reports for example, you know which one the report refers to.
To allocate an identifier:

1. Select the **Unit ID** option on the Main Menu.
2. Press the **b-button**. The cursor shifts to the left of the screen.
3. Input the identifier you want. This over-types any existing identifier.
4. Press the **b-button** again. The new details shift back to the right of the display.

12.11 Printed reports

The two types of report

The 795x can print out reports which give you information about the state of the system. There are two types of report:

- **Current report** This shows the data currently stored in a list of up to 20 locations which you specify.
- **Alarm log report** This shows the current contents of the alarm log, *plus* data from a list of up to 20 locations.

How to define a list of locations for reports

Find and note down the location IDs for all parameters you want to include in the list. (If you are unsure how to find location IDs, it is explained in the section on configuring Multiview.)

NOTE: If you have more than one 795x, it is advisable to include the Unit ID in the report list so that you know which instrument the report refers to.

Use the five-page menu shown in the diagram to define your list. Note that your list can include up to 20 locations.

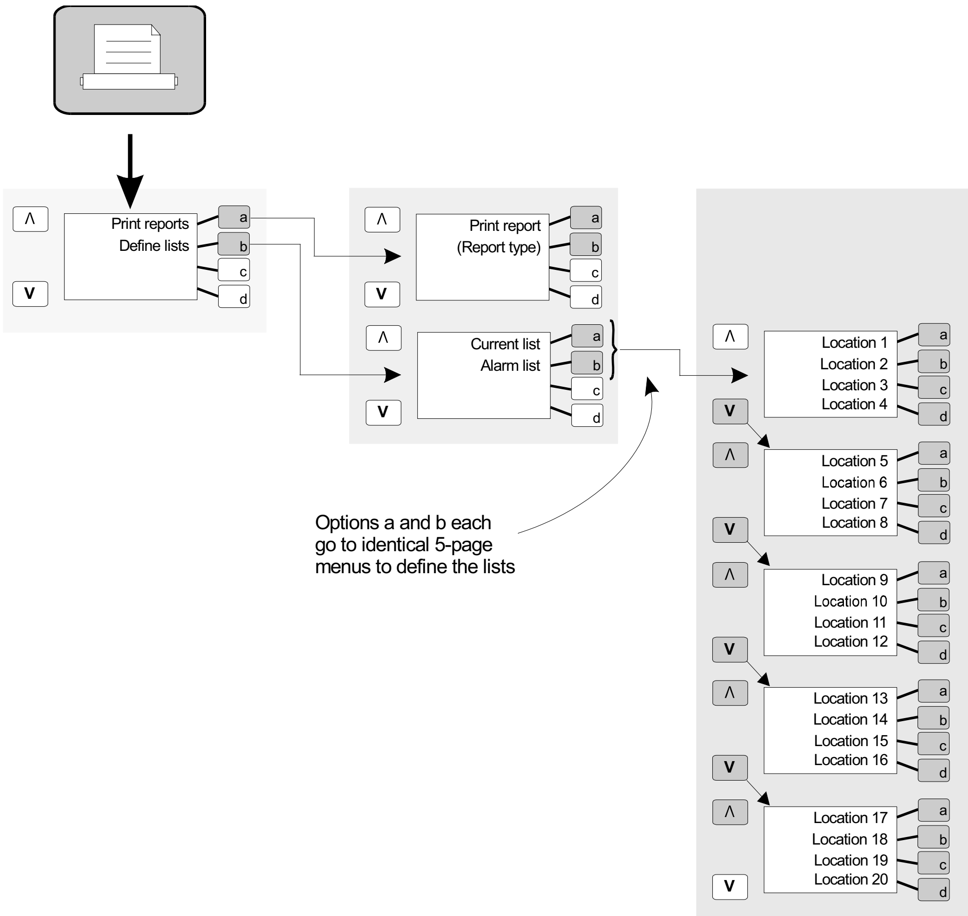


Figure 12.2 Defining lists and printing reports

How to print a report

1. Referring to the diagram, select “Print reports”.
2. Select to print either an Alarm Log or Current Report. (There is a third selection - “Idle” - which lets you leave the menu without a report being printed.) The report is printed immediately.

Some typical reports

```
CURRENT REPORT
================
PRT input channel 1     0       Deg.C   SET
TIME PERIOD I/P 3B      0       nS      SET
************* END OF REPORT ******************
```

```
ALARM LOG REPORT
==================
1995/01/02 00:11:17 OFF # Alarm power out     SYSTEM
1995/01/02 00:05:46 ON  # Alarm power out     SYSTEM
1995/01/01 23:59:50 OFF # DBM corrupt sig.    SYSTEM
1995/01/01 23:59:49 ON  # Aout no cal       4 SYSTEM
1995/01/01 23:59:49 ON  # Aout no cal       3 SYSTEM
1995/01/01 23:59:49 ON  # Aout no cal       2 SYSTEM
1995/01/01 23:59:49 ON  # Aout no cal       1 SYSTEM
1995/01/01 23:59:49 OFF # Alarm power out     SYSTEM
1995/01/01 23:59:33 ON  # Alarm power out     SYSTEM
1995/01/01 23:59:49 ON  # DBM corrupt sig.    SYSTEM
PRT input channel 1     0       Deg.C   SET
TIME PERIOD I/P 3B      0       nS      SET
Turb2  err increment  0
Analog 7 Input mode 4-20mA input
************ END OF REPORT ********************
```

13. Routine maintenance and fault finding

13.1 Cleaning the instrument

You can use a cloth or sponge and water clean the outside of the instrument. Do not use caustic cleaning agents or abrasive materials.

13.2 Fault finding

Although the instrument is designed to be extremely reliable it is possible that faults may arise at some time or another. The fault-finding charts show the most likely faults and explain how to trace their causes and put them right. If you cannot cure a fault yourself, contact your supplier or the manufacturers for help.

Note:

- Use the “Health Check” facility on the *795x* to monitor a variety of measurement parameters, including time period inputs, analogue inputs and status inputs and outputs. This can be used as a diagnostic aid if the system seems to be faulty.

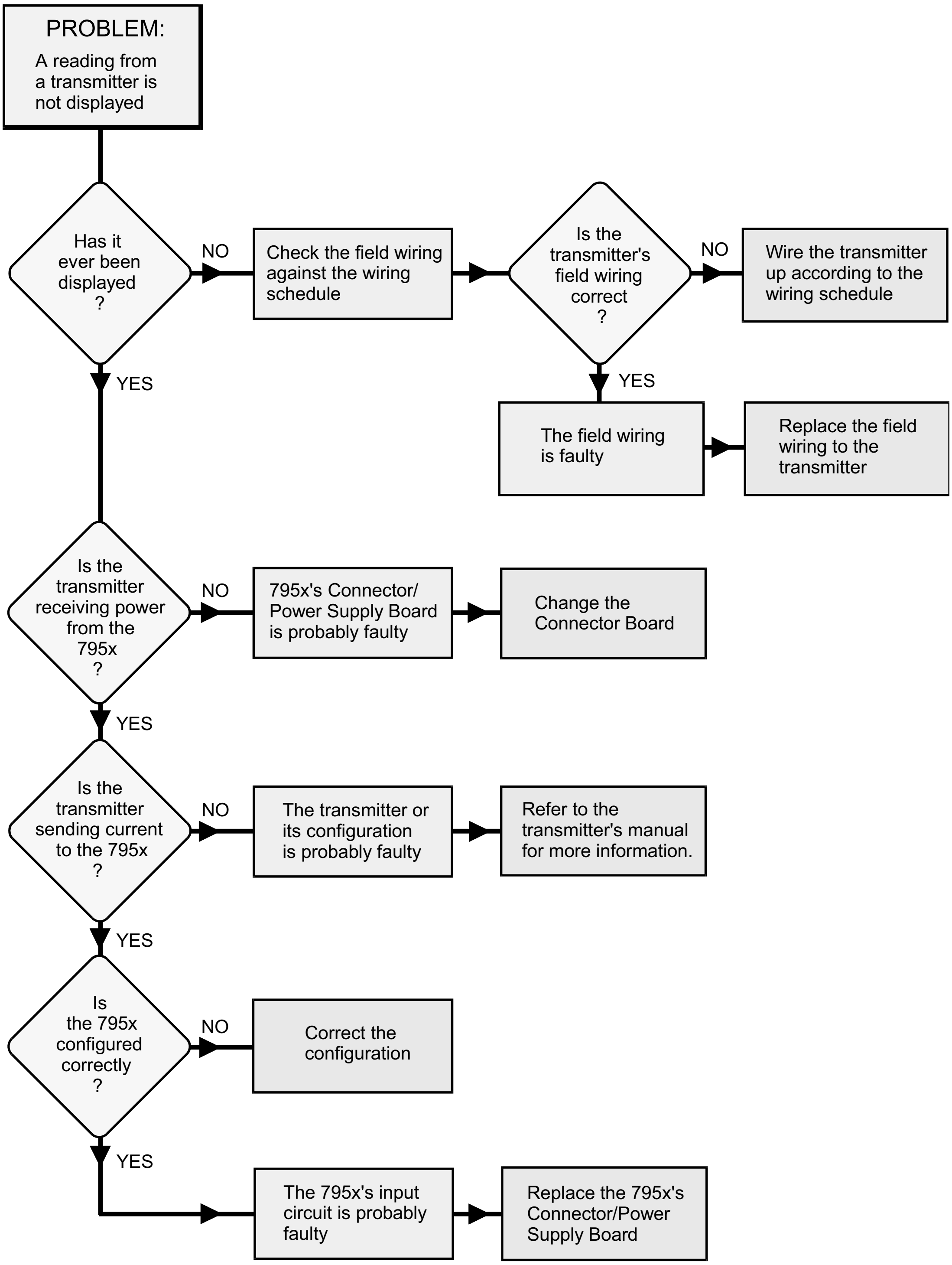


Figure 11.3: Fault-finding chart 1: No reading from a transmitter

⚠ **Caution:**

- Whilst carrying out this procedure, you must wear and earthed wrist strap at all times to protect the instrument against static shock.

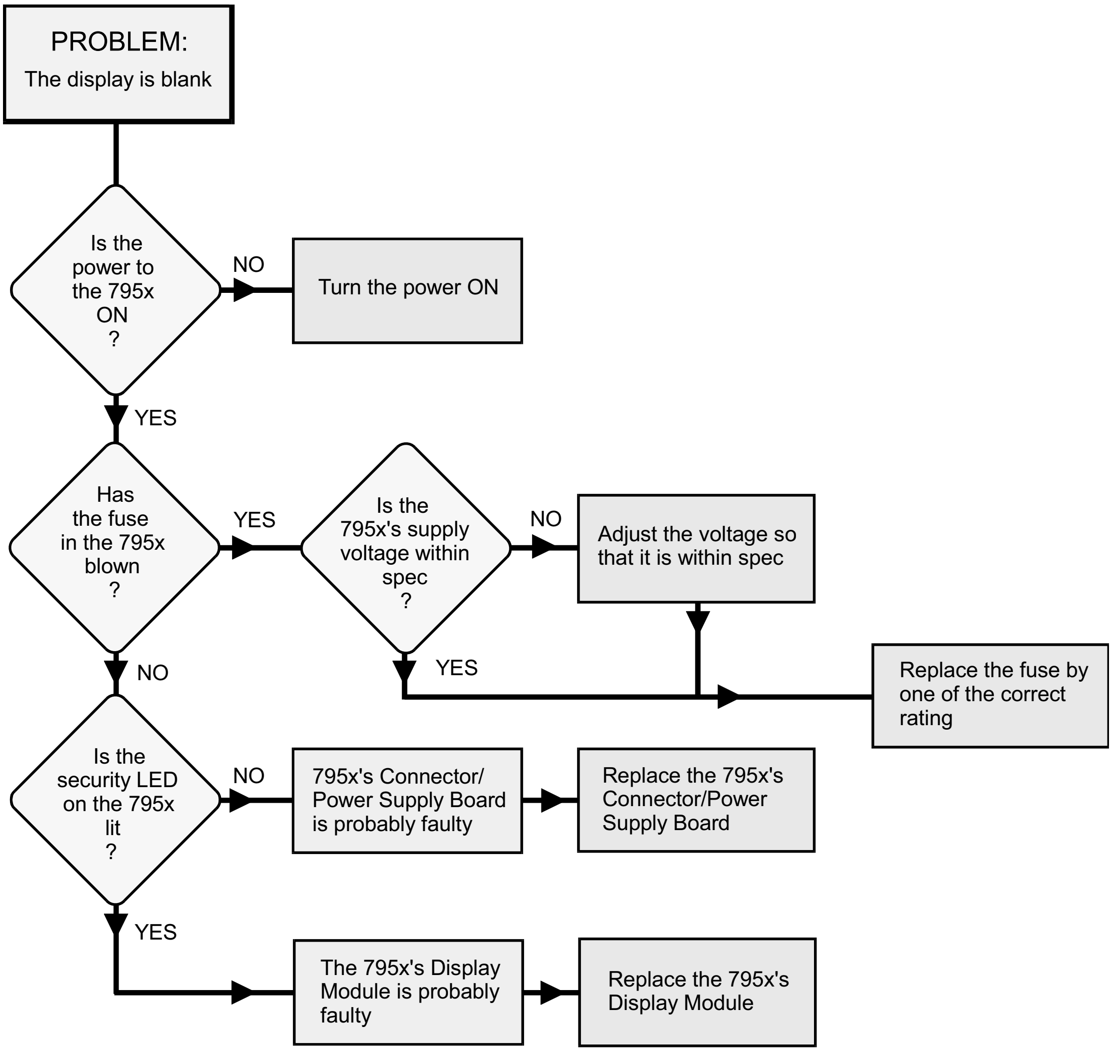


Figure 12.2: Fault-finding chart 2: The display is blank

14. Removal and replacement of parts

> **Warning:**
> - Electricity is dangerous and can kill. **Disconnect the power supply before making any connections or dis-assembling the *7951*.**

14.1 Front Panel Assembly

1. Undo and remove the four screws which secure the Bezel to the case. Withdraw the Front Panel Assembly to the limits of the connecting wiring then lay it on top of the case.

2. Partially withdraw the Processor Board then disconnect the two connectors from the Processor Board. The Front Panel Assembly is now free.

3. Replace all items by reversing this procedure. Take great care to ensure that the cables are not pinched on re-assembly.

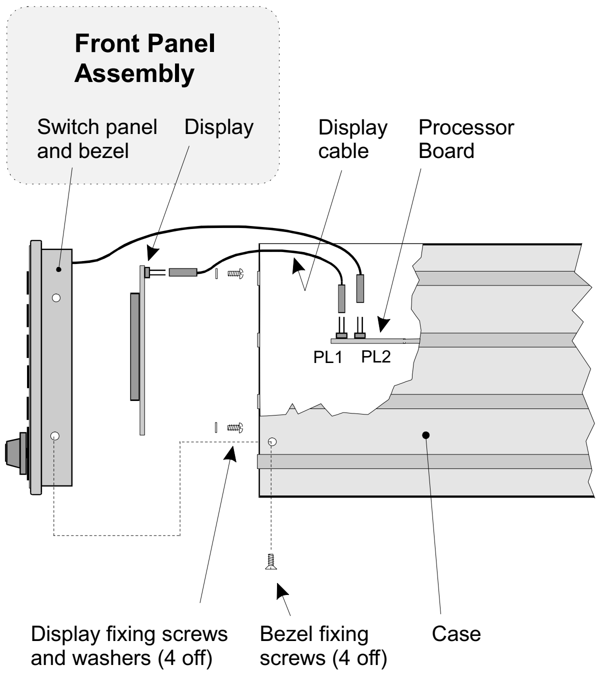


Figure 14.1: Removing the Front Panel Assembly

14.2 Display

1. Remove the Front Panel Assembly as explained in Section 14.1.
2. Undo and remove the four screws and washers which attach the display to the Front Panel Assembly.
3. If required, unplug the ribbon cable from the display.
4. Replace all items by reversing this procedure.

14.3 Switch Panel

1. Remove the Front Panel Assembly as explained in Section 14.1
2. Undo the four screws and washers which attach the display to the bezel. Remove the display.
3. Un-solder the flexi cable from the key switch. Remove the spring clip from the switch then withdraw the switch from the case.
4. Undo and remove the four nuts and washers which attach the Switch Panel to the bezel. Lift the Switch Panel away.
5. Replace all items by reversing this procedure.

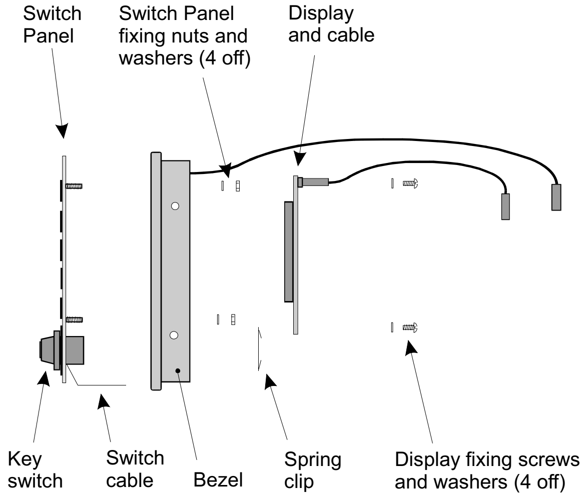


Figure 14.2: Removing the Switch Panel Assembly

14.4 Processor Board

1. Remove the Front Panel Assembly as explained in Section 14.1
2. Pull the Processor Board forwards so that it disengages from the connector at the back of the case. Withdraw the board from the case.
3. Replace all items by reversing this procedure. Take great care to ensure that the cables are not pinched on re-assembly.

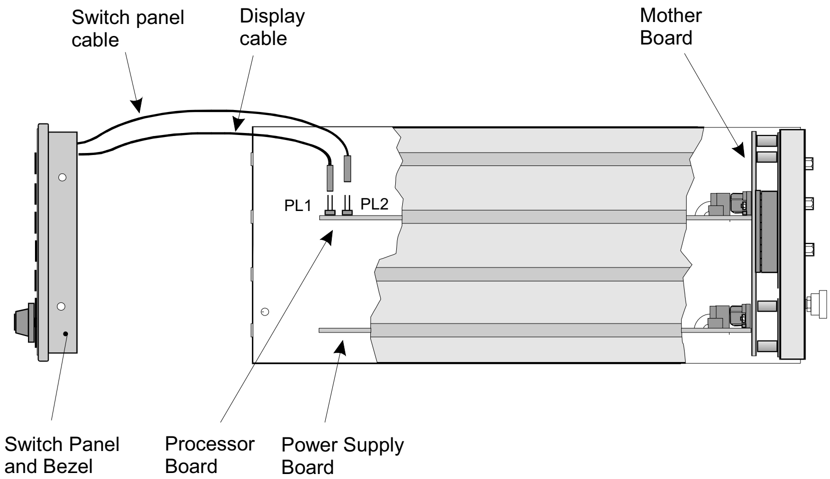


Figure 14.3: Removing the Processor Board and Power Supply Board

14.5 Power supply board

1. Undo and remove the four screws which secure the Bezel to the case. Withdraw the Front Panel Assembly to the limits of the connecting wiring then lay it on top of the case.
2. Pull the Power Supply Board forwards so that it disengages from the connector at the back of the case. Withdraw the board from the case.
3. Replace all items by reversing this procedure. Take great care to ensure that the cables are not pinched on re-assembly.

14.6 Connector Board

1. Remove the Rear Panel Assembly as described in Section 14.9.
2. Remove the Mother Board as explained in Section 14.10.
3. Unscrew the threaded hexagonal spacers on top of the Connector Board, then lift the Connector Board off the studs.
4. Replace all items by reversing this procedure. Take great care to ensure that the cables are not pinched on re-assembly.

14.7 Fuse

1. Undo and remove the four screws which secure the Bezel to the case. Withdraw the Front Panel Assembly to the limits of the connecting wiring then lay it on top of the case.
2. Slide the Power Supply Board out of the case.
3. Referring to the diagram, find the fuse and gently prise it out of the fuse holder.
4. Press the replacement fuse into the fuse holder. Make sure that the fuse is of the correct type and rating as specified in Chapter 15.
5. Replace all items in the reverse order of removal. Take great care to ensure that the cables are not pinched on re-assembly.

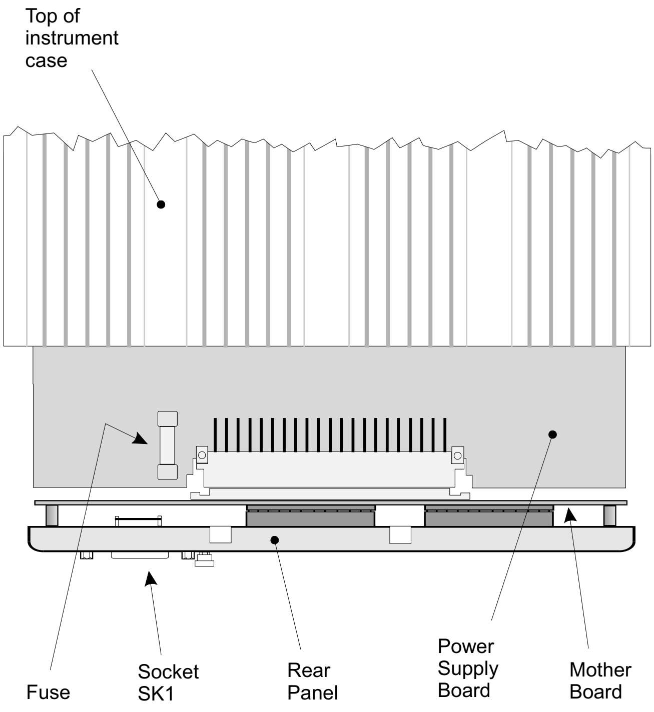


Figure 14.4: Where to find the fuse on the Power Supply Board

14.8 Back-up battery

1. Ensure that the unit is disconnected from all power supplies.
2. Ensure that a new battery (CR2430) and a thin edged, **non-conductive** implement are within easy reach.
3. Undo the six captive screws which attach the front panel assembly to the case.
4. Carefully lift the front panel assembly away from the case.
5. Undo the yellow and green Earth lead from the panel. **Do not undo** the connecting ribbon cables.
6. Locate the back-up battery on the Processor Board.
7. Referring to the diagram below, use a **non-conductive** implement to gently lever the battery upwards from near the rear of the clip. As soon as the battery lifts up a small amount, gently ease the battery in a horizontal direction away from the holder and the clip. Keep the battery in contact with the clip.

DO NOT LIFT UP THE CLIP MORE THAN NECESSARY TO MOVE THE BATTERY.

8. Keep the battery in contact with the clip until you are prepared to insert a new one.

   When the clip loses contact with the battery, there is a maximum of **10 seconds** before all configuration and database information is lost.
9. Once prepared, remove existing battery and then slide the new one under the clip and into the holder - observing the polarity symbols. Complete this action within 10 seconds.
10. Replace all items in the reverse order of removal.

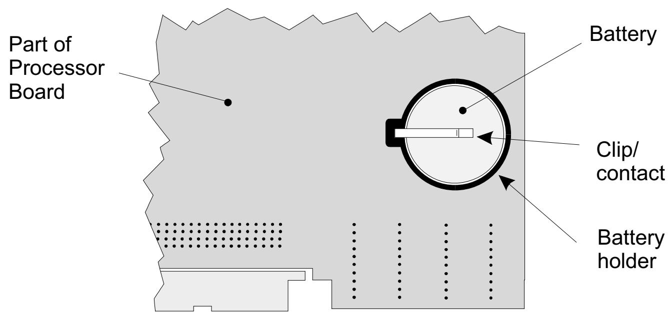


Figure 14.5: Where to find the back-up battery on the Processor Board

14.9 Rear Panel Assembly

> ⚠ **Warning:**
> **It is strongly recommended that in order to ensure continued compliance to EMC directives, you do not attempt to remove the rear panel assembly, but return the instrument to the factory.**

The instructions given below should only be carried out if it is absolutely necessary.

1. Remove the Front Panel Assembly as explained in Section 14.1
2. Pull the Processor Board forwards so that it disengages from the connector at the back of the case. Withdraw the board from the case.
3. Pull the Power Supply Board forwards so that it disengages from the connector at the back of the case. Withdraw the board from the case.
4. Remove the four screws which secure the Rear Panel Assembly into the case.
5. Withdraw the Rear Panel Assembly from the case, taking care not to bend the metal spring clips on the top and bottom of the Connector Board.
6. Replace all items by reversing this procedure. Take great care to ensure that the cables are not pinched on re-assembly, and ensure that the metal clips are not bent or damaged.

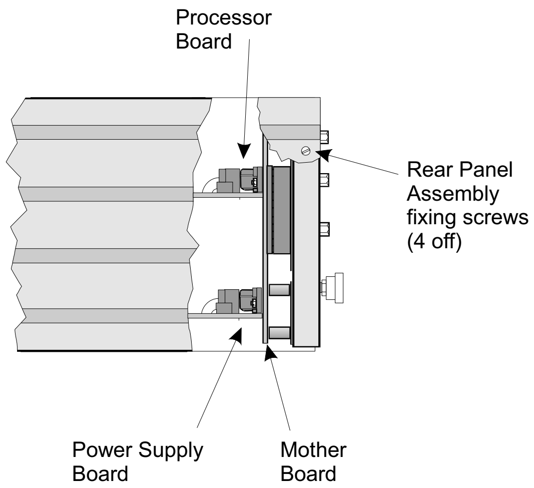


Figure 14.6: Removing the Rear Panel Assembly

14.10 Mother Board

> **Warning:**
> **It is strongly recommended that in order to ensure continued compliance to EMC directives, you do not attempt to remove the rear panel assembly, but return the instrument to the factory.**

1. Remove the Rear Panel Assembly as described in Section 14.9.
2. Referring to the diagram, undo and remove the six screws and washers which fix the Mother board to the rest of the Rear Panel Assembly.
3. Using a straight pull, carefully lift the Mother Board clear of its four connections to the connector board. The Mother Board is now free.
4. Replace all items by reversing this procedure. Take great care to ensure that the cables are not pinched on re-assembly, and ensure that the metal clips are not bent or damaged.

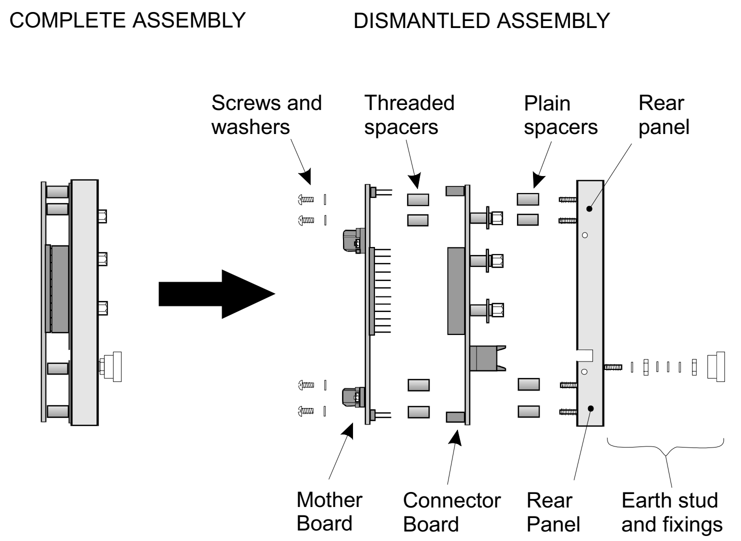


Figure 14.7: Removal of the Mother Board and Connector Board

15. Assembly drawing and parts list

15.1 What the drawing and parts list tell you

The drawing and parts list show those parts of the 7951 which you can obtain as spares.
To identify an item:

1. Find the item on the appropriate assembly drawing
2. Note the Item Number by the side of it.
3. look up the Item Number on the parts list. The parts list tells you:
    - The Part Number for the item.
    - A description of the item.
    - The quantity of the item that appears on the drawing.

15.2 How to obtain spare parts

You can obtain spare parts from the supplier from whom you bought the instrument or from the factory. In either case, you must state on your order:

- Your name, address and telephone or fax number.
- A description of the parts you want.
- The part numbers of the items you are ordering.
- The quantity of each item.

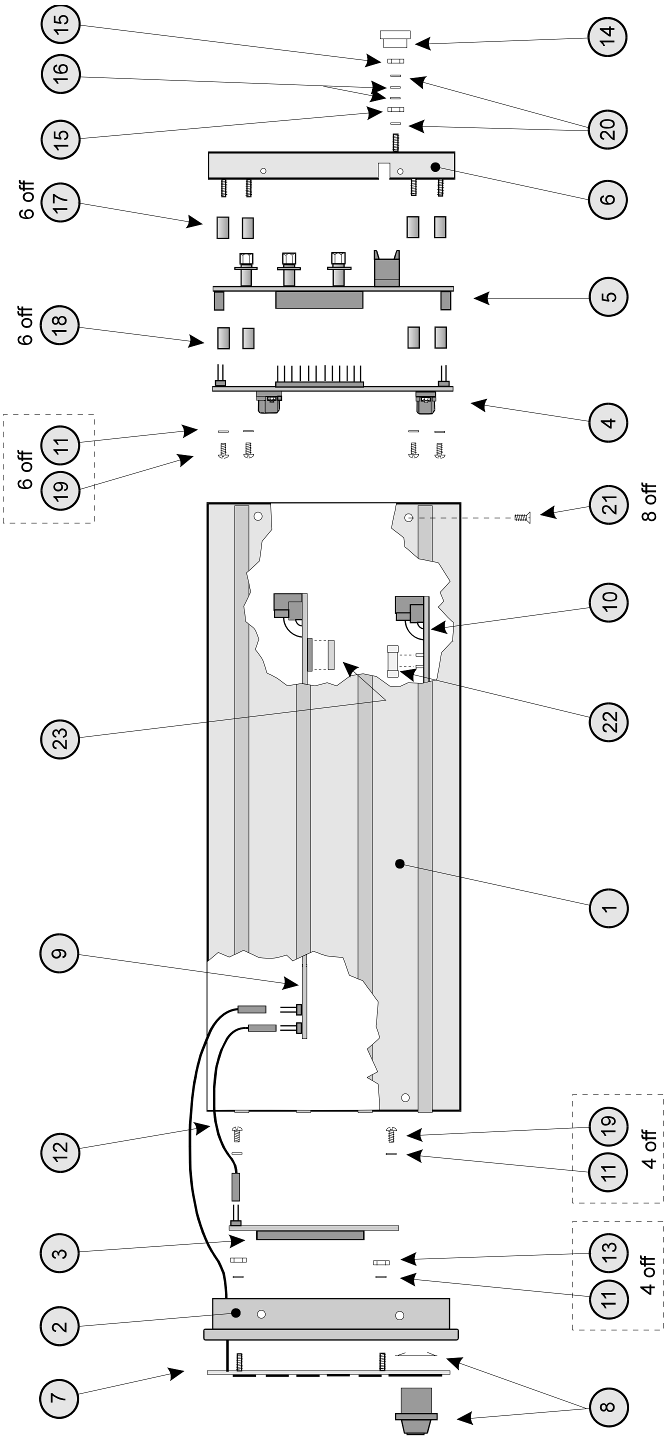


Figure 15.1: Diagram for identifying and ordering spares

Item no.	Part number	Description	Quantity
1	79513701	Instrument case	1
2	79513703	Bezel	1
3	79511206	Display assembly	1
4	79510503	Motherboard assembly	1
5	79510505 79510504	Connector board assembly **(Klippon connectors)** Connector board assembly **(D-type connectors)**	1 1
6	79513702 79513702	Rear Panel **(Klippon connectors)** Rear panel **(D-type connectors)**	1 1
7	79513705	Switch panel (with cable)	1
8	376100160	Keyswitch and retainer	1
9	79510502	Processor board	1
10	79510501	Power supply board	1
11	411129010	M3 crinkle washer	14
12	79513710	15-way cable	1
13	410031010	M3 hexagonal full nut	4
14	400001930	M4 thumb nut	1
15	410031020	M4 hexagonal full nut	2
16	411029020	M4 plain washer	2
17	412011420	Nylon spacer: 3.5mm ID x 8mm long	6
18	41530070	Hexagonal spacer: M3 x 13mm long	6
19	406803060	M3 x 6mm pan-head screw	6
20	411129020	M4 crinkle washer	2
21	406902460	M3 x 8mm pan-head screw	8
22	360106230	2 Amp glass fuse	1
23	800400380	Lithium battery CR2430	1

Appendix A Glossary

A

ADC — See *Analogue to digital converter*

Address — A number which uniquely identifies a *location*.

Alarm — An indicator which shows when a failure has occurred. Alarms are classified as System, Input or Limit.

API — American Petroleum Institute

Analogue input — An input where information is received in analogue form.

Analogue output — An output from which information is transmitted in analogue form.

Analogue to digital converter — A circuit that converts analogue voltages or currents into digital (usually binary) numbers which can then be processed by computers. The digital signal gives the amplitude of the analogue signal at a particular instant. See also *Digital to analogue converter.*

AUI — Short for ***A**ttachment **U**nit **I**nterface,* the portion of the Ethernet standard that specifies how a cable is to be connected to a transceiver that plugs into a 15-pin socket

B

Bar — A unit of pressure. 1 bar = 10^5 Nm^2.

Base condition — Base or Standard Conditions give the volume which would have been transferred if the temperature were at a pre-defined figure. The actual values for base temperature and pressure vary from country to country.

Base density — Density of a fluid measured under *base conditions.*

British Thermal Unit — The energy required to raise the temperature of one pound of water through one degree Fahrenheit.

BTU — See *British Thermal Unit.*

C

Calibrate — To assess the performance of an item of equipment against that of another one whose accuracy is known.

Calibration certificate — Each transducer is calibrated before it leaves the factory. The details (together with the transducer's serial number) are recorded on a Calibration Certificate.

Calibration constant — Among the information given on the calibration certificate are some constants (unique to that transducer) which compare the transducer's actual performance against a standard. The signal converter must know these constants before it can calculate accurate results.

The constants are designated: K0, K1, K2, and so on.

Calorific value — The energy content of a substance (usually a gas).

Chassis earth — In a large installation where the chassis and instrumentation are earthed separately, this is the "dirty" earth to which instrument chassis are connected.

Checksum — In data transmission, a checksum is a number which is added to a string of data and whose value is related to that data. It is used to check that the data has been transmitted accurately.

Connector — The part of a cable that plugs into a port or interface to connect one device to another. Most connectors are either *male* (containing one or more exposed pins) or *female* (containing holes in which the male connector can be inserted).

Configuration

1. The setting up of an instrument (by entering data, setting fallback values, setting alarms, and so on) so that it works according to your requirements.
2. The method by which transducers and other inputs and outputs are physically connected to the 7951

Conventional pipe prover — This has a volume between detectors that permits a minimum accumulation of 10,000 direct (unaltered) pulses from the meter under test.

Crystal factor — A multiplying factor which accounts for the difference between the actual frequency of a particular crystal and its theoretical frequency.

CV — See *Calorific value*

D

DAC — See *Digital to analogue converter*

Damping — Suppressing the oscillations in a vibrating body or medium.

Degree API — Used in the petroleum industry to describe the density of petroleum products. A degree API is given by:

$141.5/(\text{SG at } 60^{o}\text{F}) - 131.5$

Values lie within the range -1 to +101, the larger the number the lighter the oil.

Degree Baume — A unit on an arbitrary scale which can be converted into actual SG values. Used when describing the sugar content of aqueous solutions.

Degree Brix	A unit on an arbitrary scale which can be converted into actual SG values. Used when describing the sugar content of aqueous solutions.
Density	The measured density of the fluid in a pipeline.
Differential pressure	The difference in pressure at two points in a pipeline.
Digital to analogue converter	A circuit that converts digital signals into analogue equivalents. See also *Analogue to digital converter.*
Download	To send data or programs to another (usually subsidiary) instrument. (Opposite of *Upload*).
DP	See *Differential pressure*

E

EMC	Electro-Magnetic Compatibility
Event	A change in the system operation. Events may be caused by the user (such as setting a parameter or changing the security) or by alarms (if, for example, a fallback is invoked when the system fails).
External connection	A generic term which covers: inputs, outputs, power supplies and serial communications; in short, anything connected to the 7951.

F

Fallback mode	A description of the system when it is using a *Fallback value*.
Fallback value	A value used as a temporary substitute for a parameter when a live input which is used to calculate the parameter fails.
Flow computer	An instrument which monitors flow rates and densities of gases and liquids. It does this by communicating with transmitters such as pressure, temperature, level, flow, density and analytical instruments. These measurements are then corrected for temperature, pressure and velocity of sound.
FS	Full scale.
Full composition	The composition of a gas used in calculating energy and compressibility.

H

Hazardous area

An area where there is a risk of fire or explosion.

Health check

A check that all inputs and devices connected to the 7951 are operating normally.

Hg

The chemical symbol for the element Mercury.

Historical log

A log of every alarm received by the 7951.

Hub

A common connection point for devices in a network. Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.

A *passive hub* serves simply as a conduit for the data, enabling it to go from one device (or segment) to another. So-called *intelligent hubs* include additional features that enables an administrator to monitor the traffic passing through the hub and to configure each port in the hub. Intelligent hubs are also called *manageable hubs.*

I

Instrumentation earth

In a large installation where the instrumentation and chassis are earthed separately, this is the "clean" earth to which the instrumentation is connected.

Interrogate

To ask another part of a system to supply information.

J

J

See *Joule.*

Joule

The unit of work. $1J = 1N/m^2$.

Jumper

A metal bridge that closes an electrical circuit. Typically, a jumper consists of a plastic plug that fits over a pair of protruding pins. Jumpers are sometimes used to configure add-on (option) boards. By placing a jumper plug over a different set of pins, you can change a board's parameters.

K

K-factor

The K-factor relates the output from a flow meter to a specific set of units. For volume output meters such as turbines, it is often quoted as pulses per meter cubed.

Kinematic viscosity

The ratio of the dynamic viscosity of a fluid to its density.

L

LED
See *Light-emitting diode.*

Light-emitting diode
A diode which light up when current flows through it. LED's are usually used as indicator lights on instruments.

Limit
Limits are upper and lower values between which a measured parameter is expected to be. If the parameter is outside these limits, it can trigger an *alarm* if you have set the system to do so.

Live
A value is live if it can be altered automatically as a result of some internal calculation or transducer input. (See also: *Set.*)

Location
An area of computer memory where data is stored. Information can be written to it from the keyboard, a remote computer, or automatically by the sensors.

Location ID
A number which uniquely identifies a *location*.

M

Mass flow rate
The rate at which a given mass of fluid flows through a transducer.

MAU
Short for ***M**edia **A**ccess **U**nit,* an Ethernet transceiver

MODBUS/TCP
MODBUS/TCP is a variant of the MODBUS family of simple, vendor-neutral communication protocols intended for supervision and control of automation equipment. Specifically, it covers the use of MODBUS messaging in an 'Intranet' or 'Internet' environment using the TCP/IP protocols. The most common use of the protocols at this time are for Ethernet attachment of PLC's, I/O modules, and 'gateways' to other simple field buses or I/O networks.

Mode
The operational state of the instrument.

Monitor
To keep a constant check on the status of a system or process.

Multiples of numbers

T	tera	10^{12}	G	giga	10^{9}
M	mega	10^{6}	k	kilo	10^{3}
m	milli	10^{-3}	μ	micro	10^{-6}

Multiview
A user-defined display which can show up to four lines of information of your choice. Typically, each line comprises text (such as a parameter name) and a value for the parameter.

P

Pa	See *Pascal.*
Pascal	The unit of force. 1 Pa = 1N/m^2
Percent mass	The percentage that the mass of a substance has compared to the total mass for a mixture of substances of which it is a part.
Periodic time	The duration of one cycle of a wave-form, equal to the inverse of the frequency.
Platinum resistance thermometer	A highly-accurate thermometer, based around a coil of very pure platinum wire, which is extremely stable over time. It can be used instead of an analogue input to the signal converter or flow computer.
POST	See *Power-on self test.*
Power-on self test	A standard routine which an item of equipment goes through when it is powered up to make sure that it is operating correctly. The progress of the test is usually shown on the instrument display.
Protect ground	Another name for *Chassis earth.*
PRT	See *Platinum resistance thermometer*.
Pressure	The measured pressure of the fluid in the pipeline.
Primary variable	A variable (such as time or distance) which is directly measured.
psi	Pounds per square inch. Imperial units of pressure.
Pulse output	An output of single pulses, sent to equipment such as pulse summators or electro-mechanical totalizers.
PV	See *Primary variable*

R

Radio frequency interference	Interference from sources which transmit at radio frequencies; that is, frequencies in the range of about 100kHz to about 300GHz.
Reynolds number	A dimensionless constant given by $Re = \frac{vl}{\nu} = \frac{\rho vl}{\mu}$ Where: v = fluid viscosity l = length ν = kinematic viscosity ρ = density
RFI	See *Radio frequency interference*
RS-232	An international standard for serial data transmission. It specifies voltage levels, timing and control.

S

Saybolt viscosity A viscosity measured using methods developed by the Saybolt company. It is obtained by timing how long the fluid takes to flow out of a cup through a hole of known size. The viscosity is expressed in units of time.

Security code A code or password which a user must key in before being allowed access to all or part of a system.

Sensor Another name for a *transducer.*

Set A value is SET if it is keyed in by the user and does not change unless the user changes it. (See also: *Live*.)

Set-up routine A procedure for setting up or configuring a system.

SG See *Specific gravity*

Signal converter A device which converts one signal into another. Its main use is in quality measurement systems such as brewing where the output is used by a control or monitoring system.

Specific gravity The mass per unit volume of a fluid.

Standard condition See *Base condition*

Status The condition of part of a system; for example, whether it is on, off, and so on.

Status display A display which summarises the contents of the *Historical log* and gives an indication of the current status of the system.

T

TCP/IP Abbreviation for ***T****ransmission* ***C****ontrol* ***P****rotocol/****I****nternet* ***P****rotocol,* the suite of communications protocols used to connect hosts on the Internet. TCP/IP uses several protocols, the two main ones being TCP and IP. TCP/IP is built into the UNIX operating system and is used by the Internet, making it the de facto standard for transmitting data over networks. Even network operating systems that have their own protocols, such as Netware, also support TCP/IP.

Temperature The measured temperature of the fluid in the pipeline.

Temperature correction Transducers are typically designed to work at 20°C. A correction must be applied when working at other temperatures.

Text descriptor Text which you can enter into the signal converter. Typically, this is a parameter name when you configure Multiview.

Therm Unit of heat. 1 therm is the heat required to raise 1000 pounds of water through 100°F.

Transducer

A device which converts a physical quantity (such as temperature or pressure) to a voltage or some other electrical quantity that can be measured and analysed.

U

Upload

To receive data or programs from another instrument. (Opposite of *Download*).

V

Viscosity

In a liquid, the resistance to that force which tends to make the liquid flow.

Volume flow rate

The rate at which a given volume of fluid flows through the system.

VOS

Velocity of Sound

W

Wizard

One of the “standard” configurations whch you can select instead of configuring the 7951 from scratch. You can edit the resulting configuration to meet your requirements.

Wobbe index

A measure of the amount of heat released by a gas burner of constant orifice. It indicates the quality of the gas and is given by the expression

$$V\rho^{-\frac{1}{2}}$$

Where:

V = the gross calorific value in BTU per cubic foot at STP

ρ = specific gravity.

Appendix B Blank wiring schedule

Wiring schedule

Sheet ____ of ____

External connections			Barrier		795x Instrument	Wiring colour	Signal	Comments
Name	Type	Connector & pin no.	Pin	Pin	Connector & pin no.			

Appendix C Technical data for the 7951

C.1 What this Appendix contains

- Ordering information – understanding model codes.
- List of different types of external connections you can make to *7951*.
- Technical Specification.
- Rear panel connector diagrams and pin identity tables.
- Internal earthing arrangements.

C.2 Ordering information

Note: To find out the exact model you have, locate the model code on the rear panel, and then use this table.

Code	Product
7951MA	7951 Micro Motion Signal Converter

Code	Rear Panel	
A	Klippon connector [1]	4 analog i/p's as standard (8 analog inputs if option 8 below)
B	D-type connectors [1]	4 analog i/p's as standard (10 analog inputs if option 8 below)

Code	Software Application [2]
0	Gas applications – 1020 Signal Converter software
5	Liquid applications – 2010 Signal Converter software
Z	Non-standard software – please specify full version and issue number with order

Code	Communication Ports
3	Three serial communications ports

Code	Analog Inputs and Outputs
4	4 analog inputs, and 4 analog outputs
8	8 (Klippon) **OR** 10 ('D'-type) analog inputs, and 4 analog outputs

Code	Option Boards
N	None

Code	Connector kits for use with 25-way D-type connectors [3]
N	No commector kits required
5	5 connector kits for use with *7951MAB*

Code	Configuration Tool
N	Not required
B	PC Config + Serial Communications Cable
C	Factory configuration

7951MA	**A**	**0**	**3**	**4**	**N**	**N**	**B**	**(Typical Model Code)**

*(1) 7951MA **A** has 1 dual-pulsed flowmeter input. For dual-stream applications with pulsed flowmeter inputs, use option **B**.*

(2) Software supplied will be latest issue of Signal Converter software, unless otherwise specified on order.

(3) Connector kits are not needed with Klippon connectors (option A), but they are recommended with D-type connectors (option B). Each kit includes a 1.8m cable, and a DIN rail-mounted connector block with screw terminals.

C.3 External connections

You can make the following types of external connections to the *7951*:

- **INPUTS**
  - **Analog** — Inputs from devices which monitor continuously changing parameters and transmit analog signals. These include:
    - PRTs (PT100)
    - temperature transducers (0/4-20mA)
    - pressure transducers (0/4-20mA)
    - differential pressure transducers (0/4-20mA)
    - Viscosity transducers (e.g. Covimat 0/4-20mA)
    - Calorimeters (0/4-20mA).
  - **Pulse** — Inputs from devices which transmit information as pulses. For example, a turbine (or positive displacement) flowmeter.
  - **Time period (Dens./Visc.)** — Inputs from devices where the frequency of the transmitted signal is related to the parameter being measured. These include:
    - Density transducers (e.g. 7835 or 7826)
    - Base density transducers
    - Viscosity transducers (e.g. 7827).
  - **Status** — One of two levels, to show the state of some part of the system, such as whether a valve is open or closed.

- **OUTPUTS**
  - **Analog** — Outputs from the signal converter to those devices (such as chart recorders) which require analog outputs (0/4-20mA).
  - **Pulse** — For equipment such as pulse summators or electro-mechanical totalizers (open collector).
  - **Status** — Outputs to equipment whose status is to be changed as, for example, an output which opens or closes a valve (open drain).

- **SERIAL COMMUNICATIONS** — For receiving and sending information to other devices linked to *7951*. These include:
  - Printers.
  - Host computers.
  - Master or slave *7951s*, Chromatographs, etc.

- **POWER SUPPLIES**

Inputs	d.c. only
Outputs	d.c. only. These provide power within the 7951 and to some other external devices such as transducers.
Isolation notes	The isolation between the enclosure and all DC power inputs, signal inputs and signal outputs is: 50VDC continuously OR 125VDC for less than 15 seconds. Consequently, isolation between any two signal lines and any DC power line is: 100VDC continuously OR 250VDC for less than 15 seconds.

C.4 Maximum number of external connections

The table below lists the maximum number of external connections which you can make to a single *7951*.

Type of connection	Maximum number			
	Standard		Option 1 Extra I/O	
	Klippon	D-type	Klippon	D-type
Inputs				
Analogue (Non-SMART)	4	4	4 [1]	6 [2]
Pulse	1	2	0	0
Time period	4	4	0	0
Status	6	10	0	8 [2]
Outputs				
Analogue	4	4	4 [1]	4 [2]
Pulse	3	5	0	0
Status	6	9	0	8 [2]
Serial Communications				
RS232	1	1	0	0
RS232/485	2	2	0	0

*(1) Use ordering code 7951MAA*38N** for Klippon option 1 only, or 7951MAA*38H** for both Klippon options 1 and 2.*

*(2) Use ordering code 7951MAB*38N** for D-type option 1 only, or 7951MAB*38H** for both D-type options 1 and 2.*

C.5 Specification

General

Environmental	Working temperature	0 to +50°C (-4 to +158°F)
	Storage temperature	-20 to +70°C (-32 to 122°F)
	Relative humidity	Up to 90% non-condensing
	Bump	BS 2011 test Eb
	Vibration	Tested to IEC publication 68-2-6, Part II, frequency 10 to 150Hz, maximum acceleration $20m/s^2$
EMC	Emissions and Immunity	EN 61326-1998 industrial locations)
Safety	To BS EN 61010 standards	
Enclosure	IP50 from the front panel, only when mounted.	
Dimensions	Height	101mm (3.98")
	Width	197mm (7.76")
	Depth	257mm (10.1")
Weight	2.5kg (5.5lb)	
External connections	Type	`7951MAA******` (Klippon): Klippon multi-way connector system for all signals except communications. Separate 9-way D-type connectors for communications.
	Options	`7951MAB******(`D-type): 5x25-way D-type for all connections except communications and power. Separate 9-way D-type connectors for communications. 4-way Klippon connector for power.

Inputs

Analog	Quantity	4 off, each selectable as PRT (PT100) **or** 4-20mA
	Options	Option for extra 4-20mA inputs: `7951MAA*38***` (Klippon): 4 off `7951MAB*38***` (D-type): 6 off
	Type	0/4 to 20mA
	Span selection	Unlimited (keyboard selectable)
	Uncertainty	±0.008% of full scale at 25°C ± 0.001%/°C
	Resolution	20-bit (1 part per million)
	Sampling time	50ms per channel
	(Temperature PRT)	**Using Analog Inputs 1 to 4**.
	Configuration	4-wire: Power return line connected to Analog Input GND
	Temperature range	-200°C to +220°C for 100Ω PRT
	Uncertainty	± 0.05°C
	Resolution	± 0.02°C
	Sampling time	50ms per channel
	Energisation	<1mA average (Meets BS1904 & IEC751, <1mW in the PT100)
	Long term drift	<20ppm per 1000 hours for first 1000 hours, subsequently far less
Pulse	Quantity	`7951MAA******` (Klippon): 1 single/dual-pulse flowmeter. `7951MAB******`(D-type): 2 single/dual-pulse flowmeter.
	Options	None
	Pulse integrity checking	IP 252/76, API Ch 5.5 Level A
	Pulse interpolation / Dual-pulse chronometry	API MPMS Ch 4.6
	Type	Pulse count, maximum rise time 80ms
	Input trigger level	0.5V RMS (1.2V p-p)
	Max. voltage level	30V
	Frequency range	0 to 5kHz (dual-pulse train), minimum pulse width 100µs 0 to 10kHz (single-pulse train), minimum pulse width 50µs
Time period (Dens./Visc.)	Quantity	4
	Options	None
	Range	100µs to 5000µs
	Accuracy	± 1ns typically, ± 10ns worst case
	Resolution	2ns at 1kHz for 1-second sample

	Input trigger level	0.5V RMS (1.2V p-p), Maximum 30V
	Input impedance	10kΩ nominal
Digital (Status)	Quantity	`7951MAA******` (Klippon): 6 off `7951MAB******` (D-type): 10 off
	Options	Option for extra status inputs: `7951MAA******` (Klippon): 0 off `7951MAB*38***` (D-type): 8 off
	Input voltage required	5 to 24V per channel (opto-isolated)
	Update rate	0.5ms for prove detect, others 250ms maximum.
	Special Notices	*Status Inputs 1 and 2 are fleeting contact ball detectors for prover interface (opto-isolated). They can also be used as normal status inputs.*

Outputs

Analog	Quantity	4
	Options	Option for extra 4-20mA analogue outputs: `7951MAA*38***` (Klippon): 4 off `7951MAB*38***` (Klippon): 4 off
	Type of output	Current (powered by *7951*)
	Power	One 24V supply with capacity for 8 outputs @ 25mA each.
	Maximum loop impedence	1KΩ
	Type	0/4 to 20mA (selectable)
	Zero offset	20% or 0% (keyboard selectable)
	Span selection	Unlimited (keyboard selectable)
	Accuracy	12-bit (±0.075% of full scale)
	Resolution	1 part in 3500
	Output impedence	1MΩ minimum
	Output representation	Any measured ot computed value (keyboard selectable)
	Update rate	0.1 seconds minimum
	Isolation	All analog outputs are galvanically isolated from ground
	Long term drift	<20ppm per 1000 hours for first 1000 hours, subsequently far less
	Special Notices	1. *The maximum load impedance that the analog outputs can drive is 1K Ohms. This must include any barrier impedance and the load itself.* 2. *Analog outputs are "Active Loops". (Active loops are powered by the device providing the current output. "Passive loops" are powered externally, usually by the device receiving the current)*

Pulse	Quantity	`7951MAA******` (Klippon): 3 off `7951MAB******` (D-type): 5 off
	Options	None
	Type	Open-collector Darlington drivers
	Output rating	200mA @ 24V with 50% duty cycle
	Switch voltage	24V maximum
	Maximum frequency	10Hz
Digital (Status)	Quantity	`7951MAA******` (Klippon): 7 off `7951MAB******` (D-type): 9 off
	Options	Option for extra status outputs: `7951MAA*38***` (Klippon): 0 off `7951MAB*38***` (D-type): 8 off
	Type	Output 1 is a relay (0.5 Amp DC), all others are FET open-drain
	Rating	250mA @ 24V
	Switching voltage	24V

Communications

Serial Communications	Port 1	Physical layer	RS232 full duplex
		Max. baud rate	19K2
		Handshake	XON/XOFF
	Port 2	Physical layer	RS232 full duplex or RS485 half duplex
		Max. baud rate	19K2
		Handshake	XON/XOFF and/or RTS/CTS
	Port 3	Physical layer	RS232 full duplex or RS485 half duplex
		Max. baud rate	19K2
		Handshake	XON/XOFF and/or RTS/CTS
	Software protocols		Modbus ASCII, RTU (Master, Slave, and Peer). Data type IEEE 32 and 64-bit. 16-bit integers optional. Commands 03, 04, 06, and 16

Hardware facilities

Microprocessor	Processor	Motorola 68332
	Clock speed	24 MHz
	Computation resolution	64-bit (IEEE 754), fully-floating point maths package. Embedded Real-time operating system.
	Computation accuracy	< 1 part in 10^{11}
Memory	Program storage	2 Mbyte FLASH, *field upgradeable using serial link and Winboot software tool*
	Data storage	2 Mbyte of RAM, battery-backed by internal Lithium cell (*as used by real-time clock also*).
		Battery life is typically 2 years if 7951 is un-powered, or 5 years if powered.
		16kB FRAM non-volatile store for calibration data
	Options	None
Keyboard interface	Number of keys	30
	Key scan time	2ms
	Debounce	14ms
	Options	None
Display	Number of lines	4
	Characters per line	20 alpha numeric
	Backlight	LED, continuously powered
	Contrast	software selectable, temperature compensated
	Options	None
Real-time clock	Accuracy	1 part in 90000
	Power	Replaceable Lithium button cell (CR2430)
		Battery life is typically 2 years if 7951 is un-powered, or 5 years if powered.
	Options	None
Battery monitor	Type	ADC, indicates battery condition
	Options	None

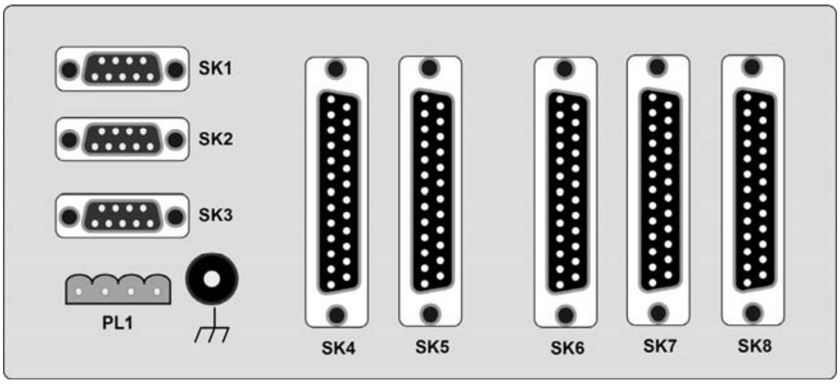
Alarm annunciation	Quantity	3 (one each for Input, System or Limit alarms)
	Type	Red LED
	Operation	Flash indicates new alarm condition. Steady indicates accepted alarm.
	Options	None
Security	Mechanisms	1. Switch located on front panel 2. Software code
	Indicator	Bi-colour LED on the front panel: 1. RED: Not secured 2. GREEN: Secured 3. ORANGE: Part-secured
	Options	None

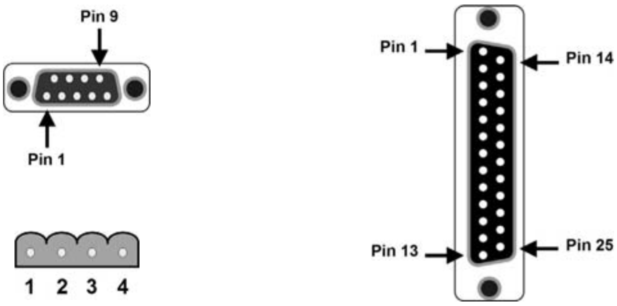
Power Supplies

Input		21V to 30V dc. Unloaded: 20W maximum. Loaded: 35W maximum. 2A worst-case start-up current
Output	General instrumentation energisation	1 x 24V nominal at 800mA
	Flowmeter energisation	Switchable voltages of 8V or 16V, current limited to 120mA
	DAC energisation	Isolated 25V output at 200mA
	Options	None

C.6 Connections

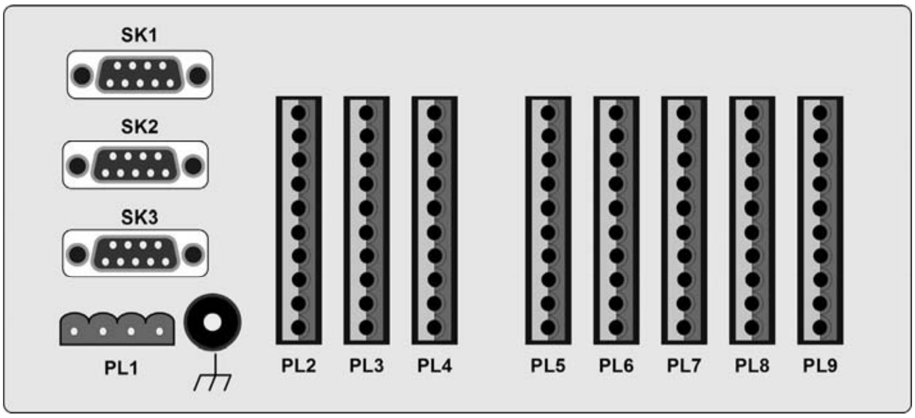
C.6.1 7951 D-type Rear Panel

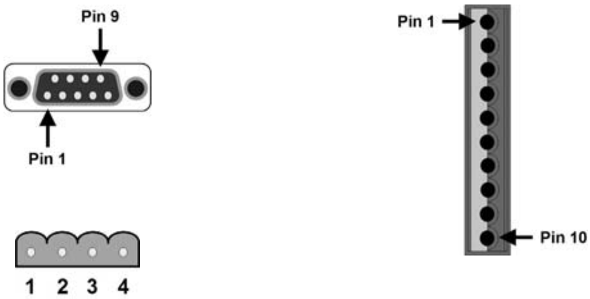




Pin	PL1	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8
1	E		Com 2 Rx/Tx+	Com 3 Rx/Tx+	Stat ip 1	Stat op 2	Turb 1 +	Ana op 1	PRT 3 pwr +
2	E	Com 1 Tx	Com 2 Tx	Com 3 Tx	Stat ip 2	Stat op 3	Turb 1 -	Ana op 2	PRT 3 sig +
3	Supply -	Com 1 Rx	Com 2 Rx	Com 3 Rx	Stat ip 3	Stat op 4	Turb 2 +	Ana op 3	PRT 3 sig -
4	Supply +				Stat ip 4	Stat op 5	Turb 2 -	Ana op 4	PRT 3 pwr -
5		Com 0V	Com 0V	Com 0V	Stat ip 5	Stat op 6	Turb 3 +	Ana op 5	PRT 4 pwr +
6					Stat ip 6	Stat op 7	Turb 3 -	Ana op 6	PRT 4 sig +
7			Com 2 CTS	Com 3 CTS	Stat ip 7	Stat op 8	Turb 4 +	Ana op 7	PRT 4 sig -
8			Com 2 RTS	Com 3 RTS	Stat ip 8	Stat op 9	Turb 4 -	Ana op 8	PRT 4 pwr -
9			Com 2 Rx/Tx-	Com 3 Rx/Tx-	Stat ip 9	Stat op com			Ana ip 5 +
10					Stat ip com	Pulse op 1	Turb pwr +	Ana op com	Ana ip 5 -
11						Pulse op 2	Turb pwr +	Ana op com	
12					Alarm NO	Pulse op 3	Turb pwr -	Ana op com	+24V dc
13					Alarm com	Pulse op com	Turb pwr -	Ana op com	0V dc
14					Stat ip 10	Stat op 10	Den 1 +	PRT 1 pwr +	Ana ip 6 +
15					Stat ip 11	Stat op 11	Den 1 -	PRT 1 sig +	Ana ip 6 -
16					Stat ip 12	Stat op 12	Den 2+	PRT 1 sig -	Ana ip 7 +
17					Stat ip 13	Stat op 13	Den 2 -	PRT 1 pwr -	Ana ip 7 -
18					Stat ip 14	Stat op 14	Den 3+	PRT 2 pwr +	Ana ip 8 +
19					Stat ip 15	Stat op 15	Den 3 -	PRT 2 sig +	Ana ip 8 -
20					Stat ip 16	Stat op 16	Den 4+	PRT 2 sig -	Ana ip 9 +
21					Stat ip 17	Stat op 17	Den 4 -	PRT 2 pwr -	Ana ip 9 -
22					Stat ip 18	Stat op com	+24V dc	Ana op com	Ana ip 10 +
23					Stat ip com	Pulse op 4	+24V dc	Ana op com	Ana ip 10 -
24						Pulse op 5	0V dc	Ana op com	+24V dc
25					Alarm NC	Pulse op pwr	0V dc	Ana op com	0V dc

C.6.2 7951 Klippon Rear Panel





Pin	PL1	SK1	SK2	SK3
1	E		Com 2 Rx/Tx+	Com 3 Rx/Tx+
2	E	Com 1 Tx	Com 2 Tx	Com 3 Tx
3	Supply -	Com 1 Rx	Com 2 Rx	Com 3 Rx
4	Supply +			
5		Com 0V	Com 0V	Com 0V
6				
7			Com 2 CTS	Com 3 CTS
8			Com 2 RTS	Com 3 RTS
9			Com 2 Rx/Tx-	Com 3 Rx/Tx-

Pin	PL2	PL3	PL4	PL5	PL6	PL7	PL8	PL9
1	Stat op 2	Pulse op +ve	Turb A ip+	Den 1 ip +	Ana op 1	PRT 1 pwr +	PRT 3 pwr +	24V pwr +
2	Stat op 3	Pulse op 1	Turb A ip -	Den 1 ip -	Ana op 2	PRT 1 sig +	PRT 3 sig +	Ana ip 5 +
3	Stat op 4	Pulse op 2	Turb B ip +	Den 2 ip +	Ana op 3	PRT 1 sig -	PRT 3 sig -	Ana ip 5 -
4	Stat op 5	Pulse op 3	Turb B ip -	Den 2 ip -	Ana op 4	PRT 1 pwr -	PRT 3 pwr -	24V pwr -
5	Stat op 6	Pulse op com	Turb pwr +	Den 3 ip +	Ana op 5	PRT 2 pwr +	PRT 4 pwr +	24V pwr +
6	Stat op 7	Stat ip 1	Turb pwr -	Den 3 ip -	Ana op 6	PRT 2 sig +	PRT 4 sig +	Ana ip 6 +
7	Stat op com	Stat ip 2	Stat ip 5	Den 4 ip +	Ana op 7	PRT 2 sig -	PRT 4 sig -	Ana ip 6 -
8	NO alarm	Stat ip 3	Stat ip 6	Den 4 ip -	Ana op 8	PRT 2 pwr -	PRT 4 pwr -	24V pwr -
9	Com alarm	Stat ip 4	Stat ip 7	24V pwr +	Ana op com	Ana ip 7 +	Ana ip 8 +	24 V pwr +
10	NC alarm	Stat ip com	Stat ip 8	24V pwr -	Ana op com	Ana ip 7 -	Ana ip 8 -	24V pwr -

C.6 Earthing

In addition to earthing the chassis, (described in chapter 4), you may have to make extra earth connections in some cases, depending on the installation requirements.

The types of connection can be split into three groups, each of which has different earthing requirements. The groups are:

Group 1 (non-isolated power supply):	Serial communications ports. Pulse outputs. Status outputs.
Group 2 (isolated power supply):	Status inputs.
Group 3 (isolated power supply):	Analogue inputs. Frequency inputs. Analogue outputs.

The diagrams on the next two pages shows you how to earth the external connections.

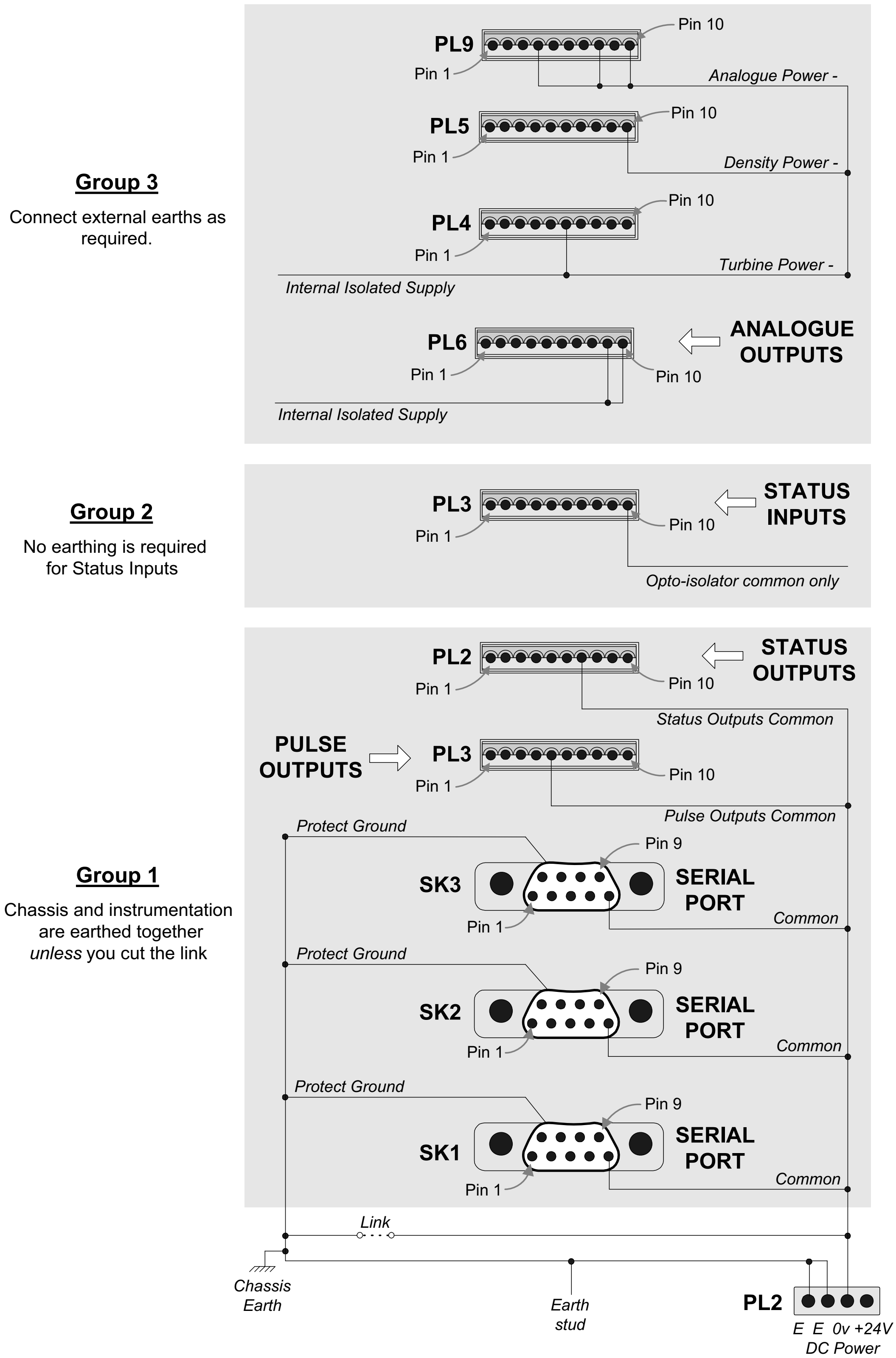


Figure C.1: Earthing arrangements for the 7951 (Klippon connectors)

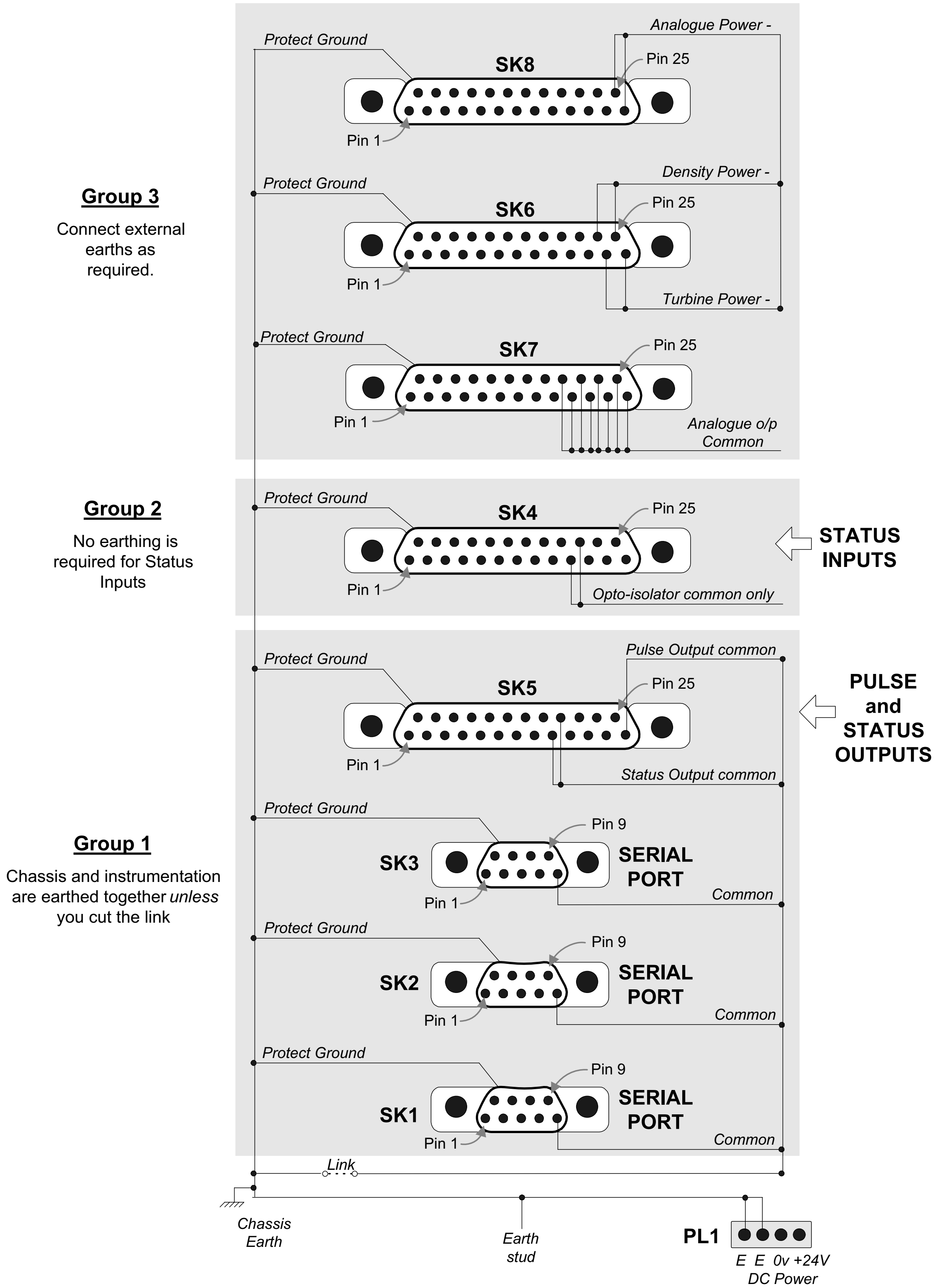


Figure C.2: Earthing arrangements for the 7951 (D-type connectors)

Earthing requirements for group 1 connections only

In general, the earthing arrangements are different for large and small installations. (A small installation may possibly consist of just one instrument.)

- **If the 7951 is part of a large installation with *separate* earths for chassis and instrumentation:**

  In this case you may (depending on the overall system requirements) earth the 7951 chassis and instrumentation separately by cutting the link on the connector board.

- **If the 7951 is on its own or in a small installation with one *common* earth for chassis and instrumentation:**

  In this case you must leave the link intact so that the chassis and instrumentation are earthed to the same point.

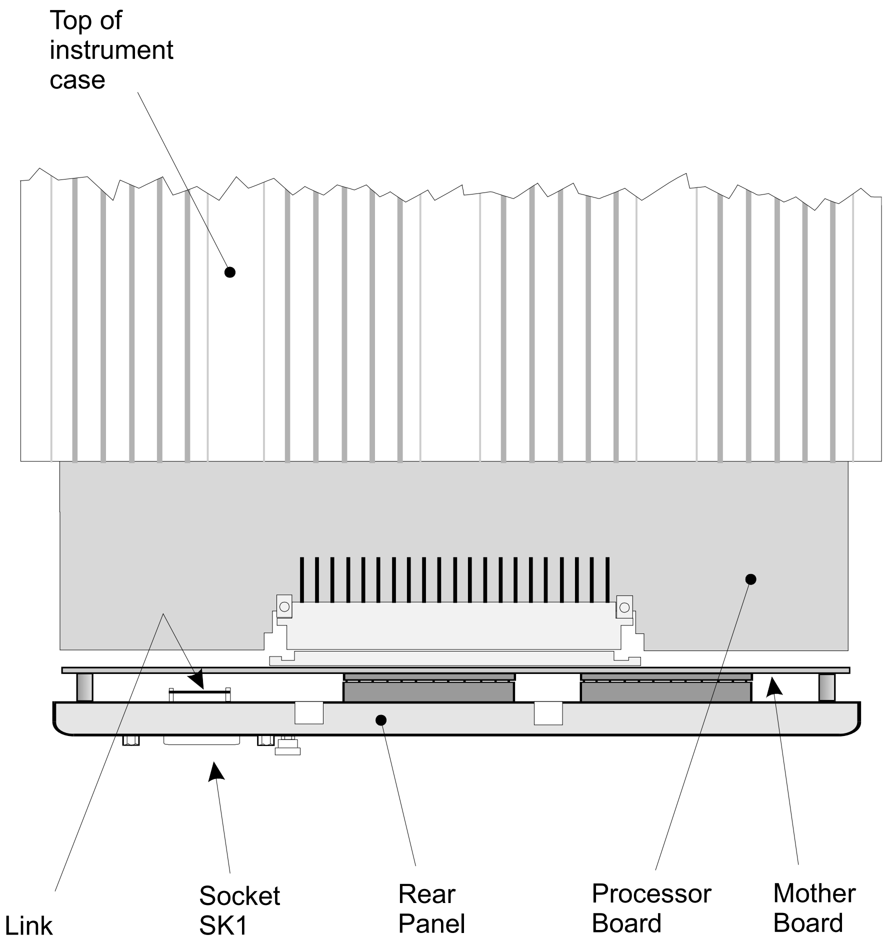


Figure C.3: Where to find the link on the connector board

Earthing requirements for group 2 connections only

The status inputs do not have to be earthed because the circuitry contains only opto-electrical components.

Earthing requirements for group 3 connections only

These depend on what sort of installation you have and the environment in which it operates. You therefore have to decide what earthing arrangements you need. It is likely that this group has to be earthed at a zener barrier earth. For further information, refer to the documentation for the external devices which are connected to the installation.

Appendix D Units and conversion factors

The figures in the following table are taken from BS 350: Part 1: March 1974:

Parameter	Imperial units	Metric equivalent
Length	1 inch	25.4 mm
	1 foot	0.3048 m
Mass	1 lb	0.45359237 kg
	1 ton	1016.05 kg
Density	1 lb/ft^3	16.0185 kg/m^3
	1 lb/gal	99.7763 kg/m^3
	1 lb/US gal	119.826 kg/m^3
Pressure	1 lb/in^2	68.9476 mbar
	1 atm	1.013250 bar
	1 MPa	10 bar
	1 N/m	10^{-5} bar
	1 mm Hg (0^o)	1.33322 x 10^{-3} bar
	1 in Hg (0^o)	33.8639 x 10^{-3} bar
Volume or capacity	1 in^3	16.8371 cm^3
	1 ft^3	0.0283168 m^3
	1 gal	4.54609 dm^3
	1 US gal	3.78541 dm^3
	1 US barrel	0.158987 m^3
Volume flow	1 ft^3/min	40.776 m^3/day
	1 gal/min	6.5463 m^3/day
Mass flow	1 lb/hr	10.886 kg/day
	1 ton/hr	1016.05 kg/hr
Energy	1 BTU	1.05506 kJ
	1 kWh	3.6 MJ
	1 therm	105.506 MJ
Temperature	^{o}F	(1.8 x ^{o}C) + 32
Viscosity (dynamic)	1 P	0.1 Pa s
	1 lbf/(ft s) or 1 pdl s/ft^2	1.48816 Pa s
	1 slug/(ft s) or 1 lbf s/ft^2	47.8803 Pa s
Viscosity (kinematic)	1 St	1 cm^2/s
	1 ft^2/s	9.29030 dm^2/s

Appendix E Data tables

E.1 The tables

Note: The equations used to derive these tables are given in Section E.2.

Density/temperature relationship of crude oil

Temp.(°C)	Density (kg/m^3)								
60	738.91	765.06	791.94	817.15	843.11	869.01	894.86	920.87	946.46
55	742.96	768.98	794.93	820.83	846.68	872.48	898.24	923.95	949.63
50	747.00	772.89	798.72	824.51	850.25	875.94	901.80	927.23	952.82
45	751.03	776.79	802.50	828.17	853.81	879.40	904.96	930.50	956.00
40	755.05	780.68	806.27	831.83	857.36	882.85	908.32	933.76	959.18
35	759.06	784.57	810.04	835.48	860.90	886.30	911.67	937.02	962.36
30	763.06	788.44	813.79	839.12	864.44	889.73	915.01	940.28	965.53
25	767.05	792.30	817.54	842.76	867.97	893.16	918.35	943.52	968.89
20	771.03	796.18	821.27	846.38	871.49	896.59	921.68	946.77	971.85
15.556	774.56	799.57	824.59	849.60	874.61	899.62	924.63	949.64	974.65
15	775.00	800.00	825.00	850.00	875.00	900.00	925.00	950.00	975.00
10	778.95	803.83	828.72	853.61	878.50	903.41	928.32	953.23	978.15
5	782.90	807.65	832.42	857.20	882.00	906.81	931.62	958.45	981.29
0	786.83	811.46	836.12	860.79	885.49	910.21	934.92	959.66	984.42

Density/temperature relationship of refined products

Temp.(°C)	Density (kg/m^3)								
60	605.51	657.32	708.88	766.17	817.90	868.47	918.99	969.45	1019.87
55	610.59	662.12	713.50	769.97	821.49	872.00	922.46	972.87	1023.24
50	615.51	666.91	718.11	773.75	825.08	875.53	925.92	976.28	1026.60
45	620.49	671.68	722.71	777.53	828.67	879.04	929.38	979.69	1029.96
40	625.45	676.44	727.29	781.30	832.24	882.56	932.84	983.09	1033.32
35	630.40	681.18	731.86	785.86	835.81	886.06	938.28	986.48	1038.67
30	635.33	685.92	736.42	788.81	839.37	889.56	939.72	989.87	1040.01
25	640.24	690.63	740.96	792.55	842.92	893.04	943.16	993.26	1043.35
20	645.13	695.32	745.49	796.28	846.46	896.53	846.58	996.63	1046.68
15.556	649.46	699.48	749.50	799.59	849.61	899.61	949.62	999.63	1049.63
15	650.00	700.00	750.00	800.00	850.00	900.00	950.00	1000.00	1050.00
10	654.85	704.66	754.50	803.71	853.53	903.47	953.41	1003.36	1053.32
5	659.67	709.30	758.97	807.41	857.04	906.92	956.81	1006.72	1056.63
0	664.47	713.92	763.44	811.10	860.55	910.37	960.20	1010.07	1059.93

The two tables above are derived from equations in the *Revised Petroleum Measurement Tables* (IP 200, ASTM D1250, API 2540 and ISO R91 Addendum 1).

Platinum resistance law (To DIN 43 760)

°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
-220	10.41	-120	52.04	-20	92.13	80	130.89	180	168.47
-210	14.36	-110	56.13	-10	96.07	90	134.70	190	172.16
-200	18.53	-100	60.20	0	100.00	100	138.50	200	175.8
-190	22.78	-90	64.25	10	103.90	110	142.28	220	183.17
-180	27.05	-80	68.28	20	107.79	120	146.06	240	190.46
-170	31.28	-70	72.29	30	111.67	130	149.82	260	197.70
-160	35.48	-60	76.28	40	115.54	140	153.57	280	204.88
-150	39.65	-50	80.25	50	119.40	150	157.32		
-140	43.80	-40	84.71	60	123.24	160	161.05		
-130	47.93	-30	88.17	70	127.07	170	164.76		

Density of ambient air (in kg/m^3) at a relative humidity of 50%

Air Pressure	Air Temperature (°C)						
(mb)	6	10	14	18	22	26	30
900	1.122	1.105	1.089	1.073	1.057	1.041	1.025
930	1.159	1.142	1.125	1.109	1.092	1.076	1.060
960	1.197	1.179	1.162	1.145	1.128	1.111	1.094
990	1.234	1.216	1.198	1.180	1.163	1.146	1.129
1020	1.271	1.253	1.234	1.216	1.199	1.181	1.163

Density of pure water (in kg/m^3 to ITS - 90 Temperature Scale)

Temp °C	0	2	4	6	8	10	12	14	16	18
0	999.840	999.940	999.972	999.940	999.848	999.699	999.497	999.244	998.943	998.595
20	998.203	997.769	997.295	996.782	996.231	995.645	995.024	994.369	993.681	992.962
40	992.212	991.432	990.623	989.786	988.922	988.030	987.113	986.169	985.201	984.208
60	983.191	982.150	981.086	980.000	978.890	977.759	976.607	975.432	974.237	973.021
80	971.785	970.528	969.252	967.955	966.640	965.305	963.950	962.577	961.185	959.774
100	958.345									

Velocity of Sound in Liquids

The values for a selection of fluids are given below. You can obtain further details from reference books such as *Tables of Physical and Chemical Constants and some Mathematical Functions* by G W C Kaye and T H Laby.

Liquid	**Temperature (t °C)**	**Velocity of Sound (c) ms^{-1})**	**Rate of Change ($\delta c / \delta t$ $ms^{-1}K^{-1}$)**
Acetic acid	20	1173	----
Acetone	20	1190	-4.5
Amyl acetate	29	1173	----
Aniline	20	1656	-4.0
Benzine	20	1320	-5.0
Blood (horse)	37	1571	----
Butyl acetate	30	1172	-3.2
Carbon disulphide	25	1142	----
Carbon tetrachloride	20	940	-3.0
Chlorine	20	850	-3.8
Chlorobenzene	20	1290	-4.3
Chloroform	20	990	-3.3
Ethanol amide	25	1724	-3.4
Ethyl acetate	30	1133	-3.9
Ethyl alcohol	20	1162	-3.6
Formic acid	20	1360	-3.5
Heptane	20	1160	-4.5
n-Hexane	30	1060	----
Kerosene	25	1315	-3.6
Menthol	50	1271	----
Methyl acetate	30	1131	-3.7
Methyl alcohol	20	1121	-3.5
Methylene Chloride	25	1070	----
Nitrogen	-189	745	-10.6
Nonane	20	1248	----
Oil (castor)	19	1500	-4.1
Oil (olive)	22	1440	-2.8
Octane	20	1197	----
Oxygen	-186	950	-6.9
n-Pentane	20	1044	-4.2
n-Propyl acetate	26	1182	----
Toluene	20	1044	-4.2
Turpentine	25	1225	----
Water (distilled)	10	1447.2	----
	20	1482.3	----
	30	1509.1	----
	50	1542.5	----

Water (sea)	-4	1430.2	----
	00	1449.5	----
	05	1471.1	----
	15	1507.1	----
	25	1534.7	----
o-Xylene	22	1352	----

E.2. Equations used to derive data tables

Density/temperature relationship

The density/temperature relationship is:

$$\rho_t = \rho_{15} \exp\left[-\alpha_{15}\Delta_t\left(1 + 0.8\alpha_{15}\Delta_t\right)\right]$$

where:

ρ_t	= density at line temperature t°C (kg/m^3)
ρ_{15}	= density at base temperature 15°C (kg/m^3)
Δ_t	= t°C -15°C (i.e. t - base temperature)
α_{15}	= tangent thermal expansion coefficient per °C at base temperature 15°C

Tangent thermal expansion coefficient

The tangent thermal expansion coefficient differs for each of the major groups of hydrocarbons. It is obtained from the equation:

$$\alpha_{15} = \frac{K_0 + K_1\rho_{15}}{\rho_{15}^2}$$

Where K_0 and K_1 are API factors which are obtained from the table:

Product	**Density Range (kg/m^3)**	K_0	K_1
Crude Oil	771 - 981	613.97226	0.00000
Gasolines	654 - 779	346.42278	0.43884
Kerosines	779 - 839	594.54180	0.00000
Fuel Oils	839 - 1075	186.96960	0.48618

Product compressibility

The definition of compressibility used to develop the table in Section 1 of the *IP Petroleum measurement Manual* is the isothermal secant compressibility, defined by the equation:

$$\bar{\beta} = -\frac{1}{V_0}\left[\frac{\partial V_1 - \partial V_2}{P_1 - P_2}\right]_T$$

Where:

$\bar{\beta}$	= isothermal secant compressibility at temperature T
V_0	= volume of liquid at atmospheric pressure
∂V_1	= change in volume from V_0 to V_1
∂V_2	= change in volume from V_0 to V_2
V_1 & V_2	= volumes at pressures P_1 and P_2, respectively
P_1 & P_2	= gauge pressure readings (Bar)

For practical purposes, when the liquid volume changes from V_0 to V_1 as the gauge pressure changes from zero (atmospheric) to P_1, the above equation is simplified to:

$$\bar{\beta} = -\frac{1}{V_0}\left[\frac{\partial V_1}{P_1}\right]_T$$

ISO Document TC 28/SC3/N248, (Generation of New Compressibility Tables for International Use) gives the following equations relating $\bar{\beta}$ to the compressibility data:

$$\log_e C = 1.38315 + 0.00343804T - 3.02909 \log_e \rho - 0.0161654 T \log_e \rho$$

and

$$\bar{\beta} = C \times 10^6 \times \text{bar}^{-1}$$

Where: T = oil temperature in °C

r = oil density in kg/litre at 15°C

The new equation (from the *API Manual of Petroleum Measurement Standards*, Chapter 11.2.1M) gives (after converting to units of kg/m and bar):

$$\bar{\beta} = 10^{-4} e^{\left(-1.62080 + 0.00021592 \times t + \frac{0.87096 \times 10^6}{\rho^2{}_{15}} + \frac{4.2092 \times t \times 10^3}{\rho^2{}_{15}}\right)} \text{bar}^{-1}$$

Where: T = temperature in °C

r_{15} = density (in kg/m^3) at 15°C and at atmospheric pressure

This equation is valid for the density range of 638 kg/m^3 to 1074 kg/m^3. For a density range of 350 kg/m^3 to 637 kg/m^3 refer to Chapter 11.2.2M in the *API Manual*.

Velocity of sound in liquids

The velocity of sound in dilational waves in unbound fluids is given by:

$$c = (\beta_a \rho)^{-\frac{1}{2}}$$

Where: c = velocity of sound

β_a = adiabatic compressibility

ρ = density

Appendix F Calculations and theory

F.1 The VOS effect on density measurements

This sub-section shows how the 795x gas flow computer software works out the velocity of sound factors that are used for correcting line density.

Two methods are provided:-

1. **Pressure method**
   This method is preferred and is for applications where live pressure measurement is available to the 795x.

2. **Specific gravity method**
   This is also known as the "User Gas Equation Method". It is for applications where pressure measurement is not available. Inputs of Specific Gravity and Temperature are required.

Equation F.1#1: Density with the correction for the effect of V.O.S.

Using:

$$\rho = \rho_1 * \left(\frac{1 + \left(\frac{K}{\tau * C_c} \right)^2}{1 + \left(\frac{K}{\tau * C_g} \right)^2} \right)$$

Where: ρ = True line density (V.O.S. corrected)……….……..….{Menu Data:< ""Meter dens A">}

ρ_1 = Line density (uncorrected)

C_c = V.O.S. of calibration gas (m/s)………………………...……..…….{See Equation F.1#2}

C_g = V.O.S. of measured gas (m/s) ………………………………………………..…………… …………..{See either **Equation F.1#3a** (pressure method) or **F.13#b** (SG method)}

K = Density transducer VOS constant

= 2.10 * 10^4 for a 7812 Gas density transducer
= (1.35 * 10^4 for a 7810 Gas density transducer)
= (2.62 * 10^4 for a 7811 Gas density transducer)

τ = Periodic time of density transducer output signal (in μs)

Also for both methods, the velocity of sound of the calibration gas is calculated by the 795x using the following equation:

<u>Equation F.1#2</u>: V.O.S. of the calibration gas

Using: $C_C = K_A + (K_B * \rho_1) + \left(K_C * \rho_1^2\right) + K_D * \rho_1^3$

Where: C_C = V.O.S. of the calibration gas (in m/s)

ρ_1 = line density (un-corrected or temperature corrected)

And: K_A, K_B, K_C and K_D are coefficients from the appropriate 'K' column of Table F.1.

The gas flow computer automatically selects the appropriate value for each 'K' coefficient by using this table.

<u>Equation F.1#3a</u>: V.O.S. of the measured gas (pure or composition) for pressure method

Using: $C_G = \sqrt{\frac{\gamma_0 * P * 10^5}{\rho_1} + K_5 * \rho_1^2 + K_6} * \rho_1^3$

Where: C_G = V.O.S. of the measured gas (in m/s)

ρ_1 = Line density (un-corrected or temperature corrected)

P = Line pressure (in barA)

And: K_5, K_5 and γ_0 are constants that must be SET into the 795x.

For a pure gas, values can be taken from the appropriate columns of table Table F.2

For gas compositions these (pure gas) constants should be modified in proportion to the volumetric fraction (percentage) of each gas component.

Table F.1: 'K' Coefficient Look-up Values

Calibration Gas	Density range	K_A	K_B	K_C	K_D
Nitrogen	0-100 Kg/m^3	349.007	-0.530984 E-01	0.595473 E-02	-0.314834 E-04
Nitrogen	0-400 Kg/m^3	348.994	-0.044632	0.297076 E-02	-0.418178 E-05
Methane	0-250 Kg/m^3	442.987	-0.579479	0.623017 E-02	0.0
Argon	0-400 Kg/m^3	318.079	0.913056 E-01	0.155044 E-03	-0.2564 E-06

Notes:

- The density range of the transducer is selected when configuring line density.
- There is no support for other calibration gases.
- Temperature is assumed to be 20°C.

Table F.2: Gas data and 795x coefficients for Cg (VOS calculation)

Gases	Molecular Weight	Gamma	Coefficients to enter (for density less than or equal to 100 Kg/m^3)		Coefficients to enter (for density greater than 100 Kg/m^3)		Approx. VOS[1]
		γ_0	K5	K6	K5	K6	m/s
Air	28.96469						
Argon	39.9480	1.677	7.21 * 10^{-3}	-54.7 * 10^{-6}	1.46*10-6	-3*10^{-6}	323.0
Carbon Monoxide	28.01055	1.395	6.14*10^{-3}	-31.0*10^{-6}	-	-	347.4
Carbon diixide	44.00995	1.290	-2.05*10^{-3}	18.7*10^{-6}	-0.38*10^{-3}	2.22*10^{-6}	264.2
Ethane	30.07012	1.194	-42.66*10^{-3}	830*10^{-6}	-0.66*10^{-3}	8.95*10^{-6}	323.0
Ethylene	28.054	1.243	-4.78*10^{-3}	52.9*10^{-6}	5.49*10^{-3}	6.50*10^{-6}	320.0
Helium	4.00260	1.664	77.3*10^{-3}	-782.4*10^{-6}	-	-	1006.0
Heptane	100.20557	1.054	0	0	0	0	155.0
Hexane	86.17848	1.063	0	0	0	0	170.0
Hydrogen	2.01594	1.407	0	0	0	0	1297.7
Hydrogen sulphide	34.07994	1.320	0	0	0	0	305.0
Methane	16.04303	1.307	4.75*10^{-3}	0.824*10^{-6}	4.75*10^{-3}	0.824*10^{-6}	442.0
Nitrogen	28.01340	1.400	5.25*10^{-3}	-28.6*10^{-6}	2.66*10^{-3}	-4.49*10^{-6}	349.0
Octane	114.23266	1.048	0	0	0	0	144.0
Oxygen	31.9988	1.397	2.50*10^{-3}	-11.08*10^{-6}	-	-	329.0
Propane	44.09721	1.132	-109*10^{-3}	4055*10^{-6}	5.88*10^{-3}	-6.16*10^{-6}	250.0
Propylene	42.081	1.154	-200*10^{-3}	8410*10^{-6}	-	-	256.0
ISO-Butane	58.12430	1.097	-2042*10^{-3}	0.4685	10.67*10^{-3}	-13.7*10^{-6}	214.0
Neo-Butane	58.12430	1.095	-2042*10^{-3}	0.4685	10.67*10^{-3}	-13.7*10^{-6}	211.0
ISO-Pentane	72.15139	1.077	0	0	0	0	188.0
Neo-Pentane	72.15139	1.076	0	0	0	0	187.0

Note:

Gas	Density range
Carbon Monoxide	0-100 Kg/m^3
Carbon dioxide	0-200 Kg/m^3
Helium	0-75 Kg/m^3
Oxygen	0-100 Kg/m^3
Propylene	0-20 Kg/m^3
Ethylene	0-350 Kg/m^3

i.e. where density could exceed 200 Kg/m^3 use K5 = -0.66 * 10^{-3} and K6 = 6.50 * 10^{-6}

[1] at Normal conditions.

<u>Equation F.1#3b</u>: V.O.S. of the measured gas (pure of composition) for S.G. method

Using: $$C_G = \frac{K}{\tau} * \sqrt{\frac{C_{G1}}{(1 - C_{G1}) + \left(\frac{K}{\tau * C_C}\right)}}$$

Where: C_G = V.O.S. of the measured gas (in m/s)

C_C = V.O.S. of the calibration gas (in m/s)……………………..……..{See <u>Equation F.1#2</u>}

τ = Periodic time of density transducer output signal (in µs)

K = Density transducer VOS constant

= 2.10 * 10^4 for a 7812 Gas density transducer
= (1.35 * 10^4 for a 7810 Gas density transducer)
= (2.62 * 10^4 for a 7811 Gas density transducer)

And: $$C_{G1} = \left[\left(1 + \frac{K_3}{\rho + K_4}\right) * \left(\left[\frac{SG}{\lambda_0 * 293}\right]_c - \left[\frac{SG}{\lambda_0 * (273 + t)}\right]_g\right)\right]$$

Where: t = Calibration temperature

SG = Specific gravity

$[\ ]_c$ = For calibration gas

$[\ ]_g$ = For measured gas

γ_0 = Low pressure ratio of specific heats (or 'Gamma')……………… (See notes below)

And: K_3 and K_4 are constants that must be SET into the 795x……………….(See notes below)

Notes:

- K_3 and K_4 are normally taken from the calibration certificate that was issued with the gas density transducer. Alternatively, the following table has typical values that can be used.
- 'Ideal' values for Specific Gravity can be taken from Table F.2. In practice, the live Specific Gravity measurements may be more appropriate.
- For a measured **pure gas**, a value for γ_0 can be taken from Table F.2.
- For a measured **composition of gas**, a value for γ_0 can be taken from Table F.2 but needs to modified in proportion to the volumetric fraction (percentage) of each gas component.

Table F.3: K3 and K4 Values

Gas Composition	Density	K_3	K_4
Nitrogen-Methane	10 to 60 kg/m^3	830.222	59.006
Nitrogen-Methane	60 to 200 kg/m^3	1389.4	205.455
Argon-Methane	60 to 200 kg/m^3	2186.01	310.079

Micro Motion®
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Operating Manual
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